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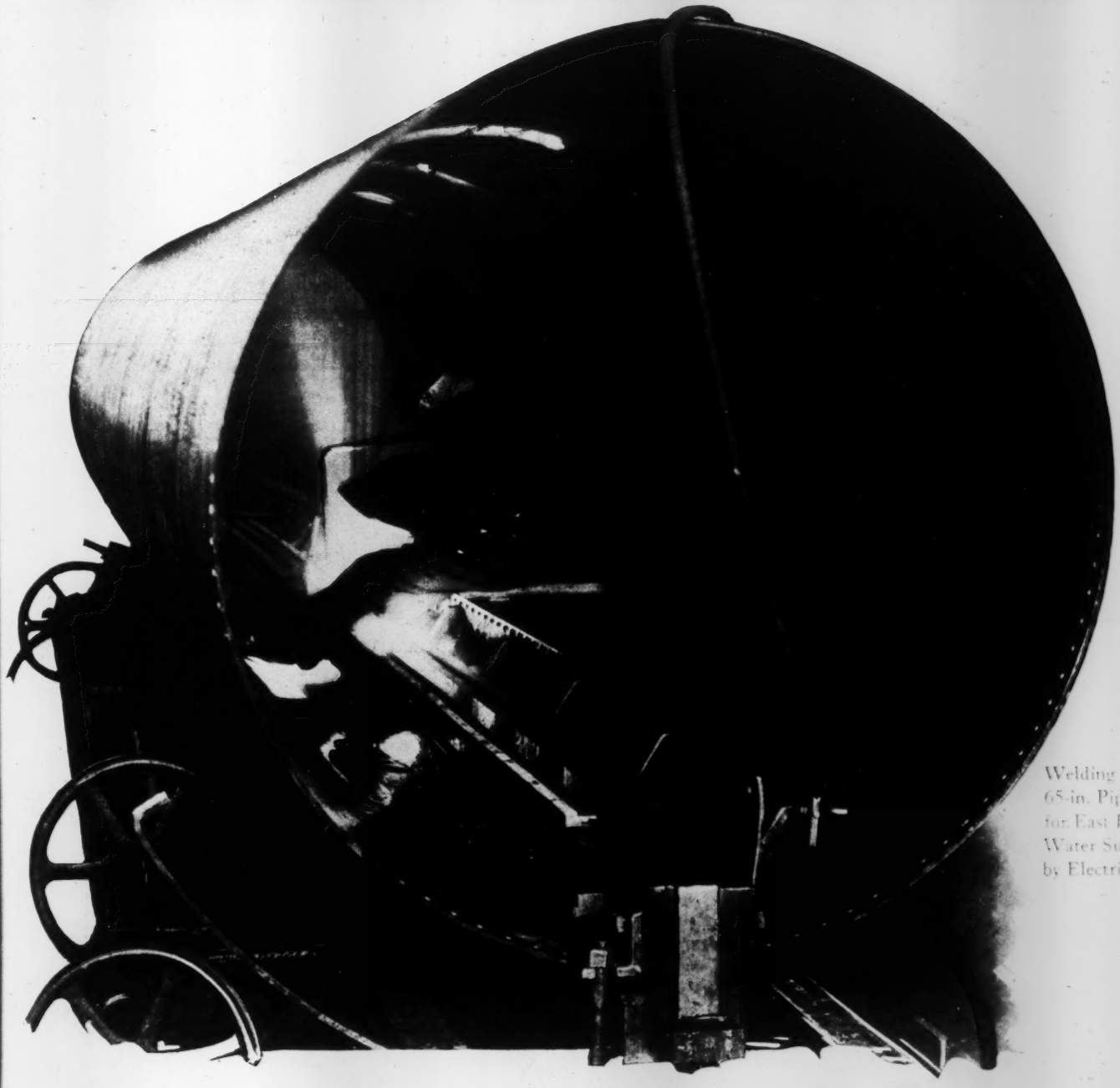

Welding 65-in. Pipe for East Bay Water Supply by Electricity

Making Electrically Welded Pipe for East Bay Conduit — Building New York's Third Subway System-III — Reconstructing the Corpus Christi Water Works — Salt Content of Colorado River Increases in 25 Years — New Union Station at Greensboro, N. C.

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Too Many Technical Division Meetings

THE meeting of the American Society of Civil Engineers at Seattle last week made very apparent that the society must revise its theory of the conduct of the technical divisions. Eight of these meetings were scheduled for one day, four simultaneously in the morning, four others in the afternoon. The general meeting was excellently attended when the location, and the number of members within easy traveling radius, are considered, but when these two hundred odd men had to be distributed over four meetings the number in at least two of them was pitifully small. The importance of the technical divisions to the society is admitted. Their formation is one of the most forward looking steps of recent years. But it is not necessary to hold a meeting of each one at each meeting of the society. There should be some recognition of the specialty of interest to be expected at any center. In Seattle, for instance, the bulk of the members attended the power and irrigation meetings, which was to be expected considering the nature of the engineering work in the Northwest. Nevertheless, when fully half of the body were in one room listening to a paper on one dam in that division, in an adjoining room a mere handful were listening to the description of another, and an exceedingly interesting, dam in the Structural Division. The idea that an engineer is a compartmentized individual who is concerned only with one branch of engineering is wrong. They all have specialties, and they are all interested in those specialties, but their specialties overlap and interweave and some provision in the program should be made for that overlapping. Once every six months is surely a short enough interval for the meeting of a technical division to hear formal papers. Some way should be found whereby fewer technical divisions meet at any one time and whereby also those that do meet simultaneously are of as diverse nature as possible.

New Subway Contractors

EVERY generation of subways in New York City has its new group of contractor builders. Not a name in the list of fifteen contractors who are constructing the Eighth Ave.-Washington Heights line described in this issue was known as a principal among the contractors for the original subway system. Only one or two are recalled as contractors for the dual subway system built ten years later in 1914-18. One speaks from recollection subject to correction but with confidence that there can be only minor error in the statements. New York's third subway system is being built by new contractors, mostly by young contractors and largely by contractors with limited previous experience in this specialty in heavy construction. There is no criticism implied by these statements; they are merely a presentation of fact. The old subway contracting firms are largely gone and gone not merely from subway building but from the contracting business. The record is a sad commentary on that business. Again criticism specifically of New York subway contracting is not implied. Its record of contractors' mortality only reflects that of the contracting business generally. All through the construction industry there are remarkably few firms of contractors active today which were in business a decade ago and it is the rare concern now which dates its contracting life back to the beginning of the century. But the hope is justified that this history may never be fully repeated. The contracting business is organizing and becoming articulate in the affairs which affect its well being. It is growing toward stabilization.

The Hazard of Explosives

HARDLY has the Navy closed the record of one tragic accident, in its valiant recovery of the hulk of the submarine S-51, than it is visited by another, last week's powder-magazine explosion at Lake Denmark. Of the whole series of major accidents which the Navy has experienced in recent years, none has so closely involved the personal interest of the citizen as this one. It has brought sharply to consciousness the danger of destruction and sudden death inherent in great stores of high explosives, and simultaneously has awakened a general conviction that if means can be found to minimize this danger they should be used, whatever the cost. Lightning, if that is what set off the initial blast at the arsenal, is not yet subject to human control, and despite the most elaborate protective devices a powder house may be struck as readily as a farm house. Even without reckoning the chance of ignition through other causes, then, any powder store is the potential seat of an explosion. But the greatness of the danger grows rapidly with the amount of explosive and its concentration in unisolated groups; and so also it can be limited by storing smaller quantities and subdividing and isolating them. Whether and to what extent this point has bearing on the New Jersey disaster will probably appear from the results of the official inquiry now under way. It is sure to be of wide public interest, for it is as much the public's as the Navy's problem how to maintain adequate supplies of necessary explosives and yet keep the inevitable hazard down to a minimum. The inquiry should also furnish better knowledge than has yet been available as to the width of the danger zone surrounding a store of high explosives. Such knowledge will be of immediate value to those responsible for community life and mechanism, since it will give a definite basis for protecting civil populations and travel routes, by keeping them at a safe distance. Governmental and community action alone can be depended on for this protection, which is

beyond the knowledge and power of the individual citizen. If the Lake Denmark explosion shall become the starting point of definite, carefully planned action to bring about such protection, at least part of the sacrifice of life and property which it claimed may be redeemed.

Protecting a President

PRE-INSPECTION of the water supply of White Pine Camp, the Adirondack summer quarters of President Coolidge, by the deputy commissioner and chief sanitary engineer of the New York State Department of Health may well serve as a basis for similar inspection of the water supply of any and every summer camp in the country. Yet of the millions who have been or will go to camp or cottage in the mountains or by river, lake or ocean this summer how many will be amply protected by the competent inspection that so vital a matter demands? State or local health board inspection is inadequate, with the men and money provided, to cover even the public and semi-public camping places and cottage groups, while for the isolated camps and cottages no public inspection whatever is possible. Fortunately, these dangers and means of avoidance are far more generally known today than ever before, while for those who wish it, bulletins may be had for the asking from most of our state boards of health. Nevertheless, so much chance is there for improvement in the sanitation of both public and private summer camps, and also in the vast number of one-night automobile camps, that there is no ground for complacency on anybody's part, whether public official or humble recreation seeker.

Group Accident Prevention

ORGANIZED accident prevention is a practice of slow growth among constructors. Individual large firms of builders have had their safety engineers and accident prevention and relief measures for perhaps a decade but group organization for the same purpose dates back only six years to the undertaking of the Detroit General Builders' Association now a chapter of the Associated General Contractors. Incidentally this group of constructors has by organized safety work cut down its accident loss one-half in five years. The record has been an inspiration. Now the Texas branch of the Associated General Contractors has organized in connection with a group plan of insurance an accident prevention department with a trained safety engineer in charge. A code of safe practices has been compiled and educational and enforcement methods have been inaugurated. The action of the Texas constructors is a noteworthy one. They have begun well. There remains for each individually to learn and apply the lessons of all accident prevention experience which is that no accident prevention department or committee or bureau however expertly headed and skillfully managed can prevent accidents. This is the individual task of each contractor. The safety director can organize group safety work, advise the individual concerning methods and direct the fight against a persistent foe but the individual contractor must do the fighting. It is this individual effort that has made the safety work of the Detroit General Builders' Association a record of high accomplishment.

Zoning Aid

DETERMINATION to save something out of the wreck of zoning in New Jersey caused by ultra-conservative court desicions persists in a number of municipalities. The city of Elizabeth has under consideration a plan which bids fair to give a worth while amount of assistance if wisely formulated and executed. It is to lessen the encroachment on residence districts of gasoline stations and other commercial establishments through the medium of building codes. Thus, gasoline stations located within a stipulated number of feet of any frame dwelling might be prohibited. This is only one of many ways that some of the ends sought by zoning ordinances might be effected through building codes, especially in communities where such codes are far from what adequate and reasonable fire protection regulations demand. Co-operation by building code and zoning specialists would be essential to give promise of the best results from the viewpoint of both. There should be no overstraining in such a plan, either in the framing or enforcement of ordinances.

The New York City Planning Committee

WHEN the population of New York City reaches the 30,000,000 forecast of the late Nelson P. Lewis, wonder will be expressed over the backwardness of the city officials in establishing a city planning department as one of the most important divisions of the city government, which it is to be hoped will have been done long before there are 30,000,000 people in New York City. Retrospective glances will show that early in the nineteenth century a special commission made a plan for the extension of the city northward over Manhattan Island; but that was merely a street plan and showed no conception of what the city and its needs would be a century later.

Early in the present century a progressive city administration recognized the need for comprehensive city planning. A notable report on the subject was made in which, as in the other forward looking engineering activities of the city over a long period, Mr Lewis took a large part. Although this and immediately subsequent planning studies were directed by a committee on city plan, created by the Board of Estimate (of which Mr. Lewis was long chief engineer) little ever came of them and the committee went out of existence, in effect if not in fact. Quite different was the fate of the work of the notable committee on building heights and related matters, which resulted in the first comprehensive zoning ordinance ever passed by an American city (1916)—a precursor of hundreds of the kind.

The World War and changes in the city administration were in part responsible for the lapse in official attention to city planning in New York, a lapse all the more remarkable because it was such a departure from notable beginnings. Meanwhile it became more and more evident to those devoted to city planning, either as practitioners or as advocates of this line of civic progress, that efficient city planning does not stop at a given line but includes adjacent municipalities and even broad rural areas. So, in the past few years regional planning has come to the front. Already there are a dozen or more regional planning organizations

between our great ocean fronts and more than that number in Great Britain. In the United States these bodies have little or no governmental status but are voluntary organizations of public spirited citizens with such funds only as are provided by private subscription. In at least one case, Chicago, there is a substantial contribution from a public treasury.

Outstanding among all the regional planning studies is that which started several years ago under the ponderous name, Russell Sage Foundation Committee on Plan of New York and Environs. Recently, falling into line with the nomenclature of the day, Regional Plan of New York is the designation used. This is a non-official body. It is amply provided with funds, has a large and diversified office and field staff, a number of eminent consulting specialists, and a city planner of international experience as director.

The Committee on Regional Plan of New York has taken pains to disclaim official status for its work or any attempt to force its conclusions upon the four hundred local governing bodies in the three states being covered by its studies. It is making a comprehensive survey of the past growth of the region in population, industry and the provision or lack of provision of needs common to the entire region, all preparatory to a forecast of the same factors for some decades hence. Highways, transit, park and recreational facilities, zoning and other needs will be included in the committee's final report, but necessarily confined to broad outline. No community, or minor group of communities, much less the entire tri-state region, can be compelled to follow the plan by any power existing or likely to exist; but the plan will point the way to unified orderly meeting of many future needs, in place of the haphazard individual cross-purpose action of the past—and of the inaction that is in some respects worse.

The great problem in the New York and other regional planning districts is how to bring the regional plan home to the many independent communities. In so far and for as long as planning, whether regional or more local, is done by voluntary agencies rather than by governmental departments with ordinance and appropriating powers backing them, there must be go-betweens to serve two purposes: (1) Influence the governing powers to adopt the plan and provide money for its execution and (2), of the utmost importance, to bring the merits of the plan home to the body of citizens and voters so they will demand its adoption.

Here is where the New York Planning Committee recently created by Mayor Walker has a part and one which is the chief if not the sole justification of creating a huge advisory committee of nearly six hundred members, composed largely of persons to whom city and regional planning must have been something vague and remote up to the time they were asked to serve on the committee. It should be noted, also, that the original state of mind of these members of the committee is much the same as that of the group and masses of whom they are more or less representative and whose approval of planning projects must be attained if they are ever to be put into effective operation.

In considering the size and polyglot character of the New York City Planning Committee it is well to remember that Chicago, the city which has done most of any in the world to convert a city plan from paper to reality—an elaborate and expensive plan, too—owes the success of the plan very largely to a huge city plan committee, the members of which have, by their representative character and hard work, obtained the endorsement of milions of expenditures, first by the city council, then by referendum vote on bond issues. With this experience in view it is reasonable not only to hope but also to expect that the New York City Planning Committee will function both in the framing and execution of a city plan for New York and in materializing the work of the Committee on Regional Plan of New York City, much of which deals chiefly with greater New York. The local committee will have at its command the extensive and fruitful studies of the regional committee and as the local committee includes members of the regional committee and of its staff of specialists, co-ordination of the work of the two committees, both in the city and the region, will be relatively easy. Such co-ordination Mayor Walker and his advisors doubtless had in mind in creating the New York City Planning Committee, a body with unlimited possibilities for achievement in the betterment of the City of New York and surrounding area with which it has so much in common although comprised in four hundred communities located in three states. Ultimately a permanent department of city planning should be given a place of influence in the government of New York City.

Highway Speed Limits

IN MOST states the speed of motor vehicles on the open highway is limited by state law to 30 or 35 miles per hour. With the modern automobile on the present-day wide, hard surfaced trunk routes, these laws have outlived their usefulness and it is only a question of years until their revision must be undertaken.

Regulation of automobile driving will in time settle down to a regulation of those things which are important. Already the tendency in enforcement is along those lines, but it is far better to revise a law than to let it stand and wink at its infraction. On straight, level highways, particularly on long runs through thinly settled territory, there is often no reason except danger of arrest to keep automobile speed under 35 miles per hour. To make the 35-mile speed limit applicable to such cases not only encourages disregard for the law, but it is as unreasonable as is the present interpretation of this same law which often legalizes that same speed at danger points where even half that speed would be dangerous. Speed alone is not a measure of risk. A far more reasonable plan is that which makes the driver at all times responsible for complete control and safe operation of his car and so long as he conforms to these requirements imposes no speed limit.

Directly in line with this, in a recent bulletin to his staff, R. M. Morton, chief engineer of the California Highway Commission, said: Alignment should be so planned as to permit of high speed. Some day there will be no speed limit on most highways." This is good policy and, we believe, sound logic. Any move toward the abolition of unnecessary limitations on highway travel is constructive and forward-looking and will help build up public sentiment in support of strict enforcement of the law where safety does require slower speeds.

Making Electrically Welded Pipe for East Bay Conduit

Shop Methods Worked Out Successfully for Making Up and Testing 65-In. Pipe, Using Steel Plates ½ In. Thick—Welding, Testing, Dipping and Wrapping Operations

THE conduit which is to bring Mokelumne River water a distance of some 90 miles to the East Bay Municipal Utility District in California is now under construction. Field work on the pipe line started in March at the San Joaquin River, near the lowest point on the line, and advanced toward Oakland, thus requiring at the outset the thickest plates used on the entire conduit. Up to June 1 about 1,280 lengths of pipe 65 in. in diameter had been made from ½- and ⅜-in. steel plates by the electric welding process. The Mokelumne project as a whole was described in *Engineering News-Record*, Dec. 11, 1924, p. 960, and progress to date was reported May 27, 1926, p. 874.

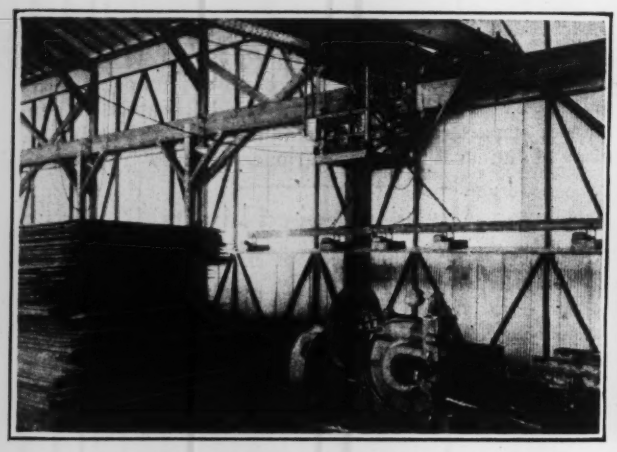


FIG. 1—LIFTING MAGNETS HANDLING PLATE
Taking 30-ft. plate from stock pile. Punch for field joint holes is in center foreground; plate is suspended above it.

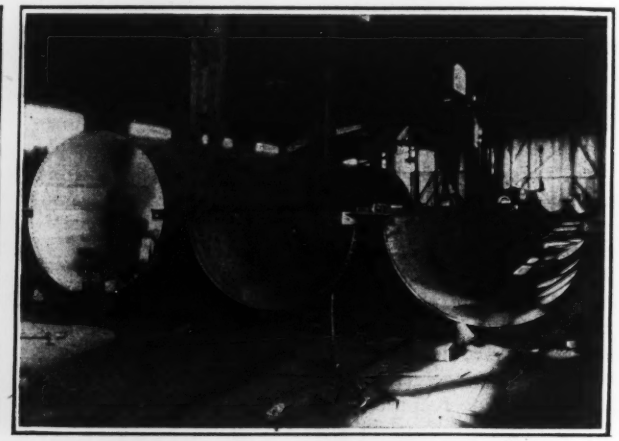


FIG. 2—ASSEMBLING 65-IN. PIPE SECTIONS
The halves are "tacked" together by spotwelding until they can be delivered to the welding machines.

In welding up pipe sections in the shop, notably at the outset, various modifications were found necessary in the original electrical equipment or in the welding process itself. Still other minor changes are yet under consideration, but as a whole the shop process as described in the following has been turning out 24 to 36 pipe lengths per day. Each length is put through a severe hydrostatic test, and is vigorously hammered with 19-lb. hammers while under a pressure of 312 lb. per sq.in.

The welding plant, located in West Berkeley, is so laid out that there is no crossing or doubling back in the continuous progress from the railroad siding, where the plates are unloaded and stored under cover, through the several processes of fabrication. The plates are unloaded from flatcars by electromagnets operated from overhead cranes, and are thus handled without bending or buckling while being stacked according to thickness and dimensions.

One of the magnet cranes takes the plates from the stock piles as they are needed. On the way to the feed table that serves the straightening rolls the crane passes over brackets for use when it is desired to turn the plates over. Turning is accomplished by placing the plate on the brackets which are then tripped and drop the plate so that it turns over as it falls to a platform below. The plate can then again be picked up by the magnets. Beyond the straightening rolls the plates pass into specially designed breaking rolls, which turn up the sides of the plates along the longitudinal edges to the curve of the finished pipe radius, thus supplying the proper curve in those portions of the plate where the main rolls would not be effective.

The main rolls are wide enough between housings to take the 30-ft. plate lengthwise and thus it is rolled to a half-section of the 30-ft. pipe length. Two half-sections are placed in a cradle with the longitudinal joint faces abutting, and are tack-welded together by the electric metallic-arc process preparatory to the work of welding the full length of the longitudinal joint.

The shop has eight electric welding machines in operation and space is provided for two more. These machines have a base or table on which the pipe section is supported and clamped by means of 30-ft. hydraulically operated mandrels. The special carbon arc-welding head travels on the mandrels inside the pipe. The section is placed on the welding table with one longitudinal seam at the bottom resting on a water-cooled fire-strip made of copper in whose top is a longitudinal groove. This fire-strip contains internal passageways for the circulation of cooling water, and the groove just below the seam provides a recess into which the bead of molten metal flows when the weld has extended entirely through the plate. Before the welding begins, a steel strip, ¼ in. thick by ½ in. wide, is laid over the seam to be welded and a clamping jack, whose function is to hold down the top water-cooled coppers, presses down on either side of the seam. The electrode is brought down close to this strip in the opening of the clamp jack and the current flows from the plate to the electrode.

The welding is accomplished by melting two abutting edges of the plates and the strip resting upon them.

When the fusion is perfect, a bead will form on the inside of the pipe about ½ in. x 5/16 in. thick and there will be a smaller but similar bead on the outside of the pipe, showing that fused metal had filled the groove in the fire-strip. The groove is ¼ in. wide by ⅛ in. thick.

In this type of welding, the Lincoln automatic carbon arc method, the welding head travels automatically

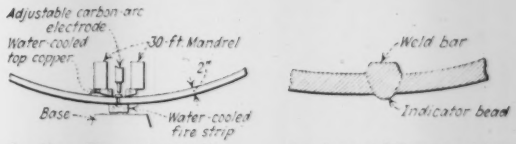
FIG. 3—WELDING MACHINE IN OPERATION
Note heavy bars in mandrel designed to prevent warping of plates due to heat of welding.

over the seam. The specially designed jack, on the other hand, is operated by means of a ratchet, directly ahead of the arc, and is under the control of the operator, so that he can specifically hold down the two top coppers in close contact on each side of the seam to be welded. The approximate speed of welding in ½-in. plates is about 12 ft. per hour. As soon as the seam on the bottom is completed, the pipe is rotated through an angle of 180 deg. and reset, and the second longitudinal seam is then welded in the same manner.

In an inspector's room at one end of the welding bay is an integrating device on which eight pens make a continual record on a circular chart of the electrical power consumption of the eight welding machines. This provides a continuous record of the performance of each machine and affords a check on progress as well as on the time and length of delays or other outages.

When both longitudinal seams have been welded the pipe lengths are swung over to the inspection floor, where the seams are carefully examined inside and outside. A carborundum wheel is passed over the inside bead, to bring the bead to a normal height, as well as to clean off impurities brought to the surface by welding, this operation being to reduce resistance to the flow of water in the pipe. Particular attention is given to the outside bead, and if perfect fusion is not shown throughout it is repaired. Two methods of repair are used. One is chipping in with a diamond-point chisel to a point where perfect fusion is made with the inside weld, refilling the place chipped out and forming a full bead with a portable metal electrode outfit. The other method of repair, which is considered preferable, is to reweld by means of the hand carbon arc. This method does not require any chipping on the outside of the pipe.

One of the chief problems in connection with the shop work has been to get a sufficient number of competent welders. To meet contract requirements as to time the



Section Through Welding Equipment — Section of Finished Weld

FIG. 4—WELDING EQUIPMENT AND FINISHED WELD

shop has to turn out about 24 sections per day. Allowing for occasional delays and normal progress this means the operation of eight welding machines on a continuous three-shift basis. It has been found advantageous to use a 4-ft. bed welding machine for training new welders and trying out prospective operators, before allowing them to weld on any pipe.

Specifications permit an offset of abutting edges up to ¼ in.; however, the offset rarely exceeds 1/16 in. In order to make the welds at each end of the pipe section smooth and continuous, slugs are placed at each end of the seam after the section is in the welding machine. These slugs are about 2 in. square. The welding is thus started on a slug at one end and finished on the slug at the opposite end. This provides a continuous weld throughout the pipe section itself and upon completion of the seam the slugs are knocked off with a hammer.

At the outset considerable delay resulted from water leaks in the bottom fire-strips and the top coppers.

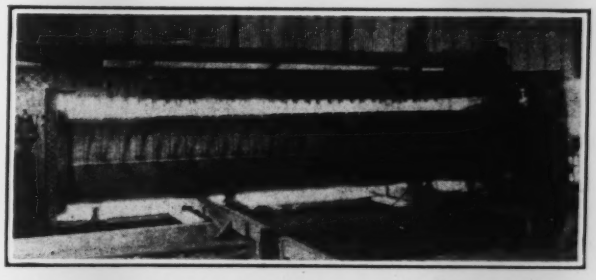


FIG. 5—TESTING MACHINE WITH SOME HAMMERS DOWN
These 19-lb. hammers have handles of adjustable length. They are tripped one at a time by attendant.

This trouble was ascribed to insufficient capacity for a flow of water through these parts and was remedied by redesigning them for a greater quantity of flow. Also no provision had been made at the outset for holding down the top coppers on the abutting plate edges. This condition was remedied by the design of the special clamping device to be moved ahead of the arc by the operator, as described in the foregoing. All eight machines have been equipped with newly designed fire-strips, top coppers and special holding-down devices

for the top coppers, and troubles due to these causes are now regarded as passed.

After inspection any supplementary hand welding that may be necessary is done either by hand carbon arc or by hand metallic arc, and the sections are then rolled into a double-headed testing machine where they are placed with the two welds in a horizontal plane. The sliding head of the machine, operated by a hydraulic cylinder, is then moved up to hold the pipe section firmly in place and the pumps which fill the

FIG. 6—SECTION ENTERING THE DIPPING TANK
Oven at the left. Sections at the right are cooling.

pipe and bring it up to specified pressure are started. Specifications require a hammer test at stipulated pressures, which vary for the various metal thicknesses, followed by a hydrostatic test at higher pressure than that under which the hammer test was made. These pressures vary as shown in the following table:

Plate Thickness	Pressures at which Hammer Test is Made (Lb. per sq.in.)	Maximum Pressures (Lb. per sq.in.)
¼	312	375
7/32	273	330
⅛	234	280

The hammer test is made by a row of hammers one foot apart on both sides of the pipe, arranged so they can swing downward under the force of gravity, striking uniform blows along the welded seam. The hammers have 2x2x6-in. steel heads weighing 19 lb. and are attached to 4-ft. handles made of steel straps 2 in. wide by ½ in. thick. The end of the handle opposite the head is held loosely by a bolt so that the head is free to swing. When ready for a test the hammer heads are supported by latches with the handles in a horizontal position. When the gage shows the specified pressure in the pipe these latches are tripped one by one by an attendant and the hammer heads fall through an arc of 90 deg. The handle lengths are so adjusted that alternate hammers strike about 1 in. above and 1 in. below the weld center line.

If a spurting leak occurs in this test the pipe section must be taken out and the leak repaired by hand welding. If sweating occurs along the weld, a pneumatic calking hammer is used to tighten up the spot where the sweating appears. It is notable that out of the 1,160 sections tested, the losses in the testing machine have amounted to approximately 35 sections, with 20 sections breaking under the hammer test and the remainder breaking between the hammer test and the maximum pressure test that followed. The sections that failed have nearly all broken in the weld itself, indicating some defect in the workmanship rather than a weakening of the metal a few inches back of the weld, such as might be charged to overheating or other causes commonly attributed to the welding. It is also to be noted that some of the sections which break in the testing machine can again be rewelded and again submitted for test, a practice which is said to have been effected with complete success.

Having passed the test the pipe section passes into a furnace where the temperature is raised to 500 deg. or more so that in the cooling that will occur between the furnace and the dipping tanks the temperature will not drop below 460 or 450 deg., the temperature of the dip. The bitumastic compound in which the pipe is dipped is contained in a vertical cylinder, heated by steam coils, with its top about 3 ft. above the floor. On being withdrawn from the furnace the pipe section is up-ended by an overhead crane and lowered slowly into this dip where it remains a few minutes and is then slowly withdrawn. Prior to going into the fur-

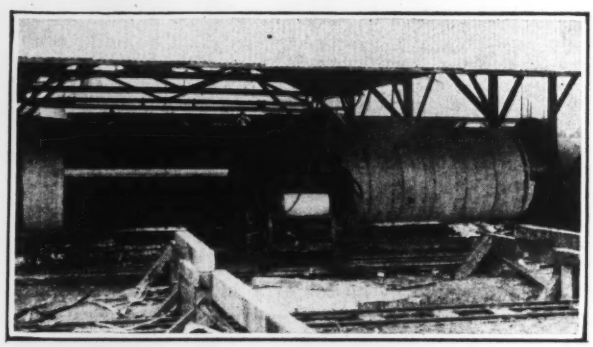


FIG. 7—SPIRAL WRAPPING MACHINE IN THE YARD
A car carrying the roll of covering and the heating kettle containing "dip" moves along the rails as the pipe is slowly rotated.

nace, 6 in. of the pipe on either end is plastered with a compound which bakes on but can later be scaled off easily. This prevents the dip from adhering to the metal and leaves the ends of the pipe free from dip ready for field welding.

After having been allowed to drain, during which time the coating has hardened sufficiently to prevent it from "running," the pipe section is placed in a specially designed spiral wrapping machine, where it is wrapped with a soil-proof pipe covering. The wrapping is lapped about 1½ in. and 6 in. of the pipe is left uncovered at either end for field work. As the wrapping goes on a stream of the same material used in the dip is fed from a heating kettle onto the pipe beneath the covering.

From the wrapping machine the pipe sections go to storage in the yard on skids, ready for shipment to the trench. At the outset delivery was made by water on barges carrying 36 sections which went by way of

Suisun Bay and a slough from the San Joaquin River to the lower end of the pipe trench. From the barge the sections were unloaded by floating derrick directly onto trucks that delivered them along the trench. When the truck haul became so long as to make the water route no longer economical sections were delivered directly by truck from the plant to the trench.

The contract for fabrication of the pipe sections and for construction of the line in the field, as well as the maintenance of the line for the first year is held by Twohy Brothers Co. and J. F. Shea Co., with the Steel Tank and Pipe Co. of California as subcontractor. The latter company supplied the photographic views accompanying this article.

Claire A. P. Duffié is president and general manager of The Steel Tank and Pipe Co. of California, C. H. Ramsden is vice-president and chief engineer, and W. F. Focha is secretary-treasurer and chief of maintenance operations. All construction on the Mokelumne project is under the general direction of Arthur P. Davis, chief engineer, East Bay Municipal Utility District.

Salt Content of Colorado River Increased in 25 Years

Analyses Show Marked Increase in Dissolved Matter Since 1900, Probably From Irrigation Along Upper River

By Carl S. Scofield
United States Department of Agriculture, Washington, D. C.

SURVEYS of the quantity and character of the dissolved salts carried by the Colorado River at Yuma were made by Prof. R. H. Forbes in 1900, by the Reclamation Service in 1905, and by the writer during the years 1923 to 1925. During the 25 years since the first survey was made there has been a large increase in the area of irrigated land in the Colorado Basin, both in the upper basin and in the delta. It appears from the three sets of analyses that the increased use of water in the upper part of the basin has resulted in an increase in the salt content of the water of the lower section of the river.

River Conditions—The quality of the water of the Colorado River with respect to the quantity of dissolved salts fluctuates annually between rather wide limits. During the flood season, May to August, the salt content is low, from 300 to 500 parts per million, while during the eight months of low water it ranges up to 1,400 parts per million. Because of these fluctuations it is necessary to make long series of observations to get a sound basis for determining the facts.

In 1900 Professor Forbes made a detailed investigation of the salt content of the river at Yuma, publishing his results in Bulletin 44 of the Arizona Experiment Station. He had a sample of water taken daily from Jan. 10, 1900, to Jan. 24, 1901, except for three intervals aggregating 16 days. These daily samples were composited into 61 samples that were tested for silt and dissolved salts. The salt content ranged from 210 p.p.m. for July 24-29 up to 1,250 p.p.m. for Oct. 2-13. The mean of the 61 analyses is 713 p.p.m. Unfortunately there is no record of the volume of discharge of the river for 1900, so that it is not possible to say whether or not the discharge conditions were near to normal.

Another series of water samples was taken at Yuma in 1905 (Jan. 1-Dec. 30) by the U. S. Reclamation Service under the direction of Thomas H. Means. The results are reported by Herman Stabler in Water Supply Paper 274 of the U. S. Geological Survey. Samples were taken nearly every day, and usually three samples were composited for a partial analysis, which included a determination of the total dissolved solids. There were 106 such determinations for the year. The mean of these is 723 p.p.m., the highest being 1,230 and the lowest 308. There is also a daily record of the discharge of the river, so that it is possible to compute a weighted mean salt content, which is 594 p.p.m. for an annual discharge of 19.7 million acre-feet.

Latest Survey—These early observations made by Forbes and by the Reclamation Service are highly important because they afford a basis for comparing present-day conditions of the river. The data as to present conditions are based on samples of irrigation water taken at the Yuma Field Station of the Department of Agriculture, located at Bard, Calif. The water is diverted from the river at Laguna dam, which is above the confluence of the Gila River, and in this respect these samples differ from the earlier ones, which were taken at a point below the mouth of the Gila. The samples taken at the field station represent each run of irrigation water, which comes approximately once a week, and in this respect also they differ from the earlier samples, which were taken daily and composited. The samples from the Bard station were collected by E. G. Noble and analyzed by James F. Breazeale.

While the present series of observations cover the period from June, 1922, up to the present, the results here reported are for three yearly periods from October 1, 1922, to Sept. 30, 1925. These periods have been used because they correspond with the discharge records for the river reported by the Bureau of Reclamation from the gaging station at Yuma.

Condensed results of the analyses for total dissolved salts are given in Table I, which includes also the results reported for 1900 and 1905. The determinations for total salts were made by evaporating filtered samples of water and weighing the residue. The table shows in column 3 the means of the analytical results. These means for the last three years are all substantially higher than the means reported for the earlier years.

The separate determinations that enter into the last three means reported in the table show approximately the same range of fluctuation as those reported previously. During the summer flood the salt content is low, but during the period of low water the salt content is high. With respect to the present use of the river water for irrigation, the means reported in column 3 of the table give a fairly true basis for estimating the quantity of salt carried to the land by irrigation water. The use of irrigation is not very much larger during the period of high water than during the spring and fall. Consequently it seems safe to assume that the water used for irrigation on lands below Laguna Dam has averaged during the past three years not far from 900 p.p.m. of dissolved salts. Since an acre-foot of water weighs about 2.72 million pounds, this means 1.22 tons of salt per acre-foot of water; and since the

annual use of irrigation water is at least 3.5 acre-feet per acre, the inference is that something like 4.25 tons of dissolved salt has been carried to each acre of irrigated land each year.

Fortunately not all of the dissolved salt carried in the irrigation water remains in solution in the root zone of the soil. A part of this salt precipitates out as the water evaporates or is absorbed by plants. This is probably true of the calcium carbonate and possibly also of calcium sulphate. Furthermore, where irrigation water is used copiously some of the salt is doubtless carried below the root zone to accumulate in the subsoil or pass out as drainage.

Weighted Salt Content—In view of the fact that the salt content of the river fluctuates widely during the year, it becomes of interest to determine as nearly as may be what the average salt content would be if the water were stored and mixed in a reservoir. This weighted mean for 1905, as well as well as for each of the last three years, is given in column 4 of Table I, while the annual discharge of the river at Yuma is given in column 5. The weighted mean salt content is, of course, lower than the simple mean because of the large volume of water of low salt content. The

TABLE I—SALT CONTENT AND DISCHARGE OF THE COLORADO RIVER AT YUMA

(1) Period	(2) Number of Analyses	(3) Mean of Analyses, P.P.M.	(4) Mean, Weighted by Discharge, P.P.M.	(5) Annual Discharge, in Millions of Acre-Feet.
1900 (Jan. 10, '00, to Jan. 24, '01)	61	713	....	....
1905 (Jan. 1, to Dec. 30)	106	723	594	19.7
1922 (Oct. 1, '22, to Sept. 30, '23)	47	896	544	16.6
1923 (Oct. 1, '23 to Sept. 30, '24)	52	839	628	12.7
1924 (Oct. 1, '24 to Sept. 30, '25)	50	997	697	11.1

weighted mean was lowest in 1922-23, when the total discharge was 16.6 million acre-feet, yet the total quantity of dissolved salt carried past Yuma was greatest in 1905, when it amounted to 15.9 million tons. For 1922-23 it was 12.3; for 1923-24 it was 10.8; and for 1924-25, 10.5 million tons.

In the preceding paragraphs the discussion has been confined to the total quantity of dissolved salts in Colorado River water. It remains to indicate the character of this dissolved material by giving the results of the determination of the more important constituents. These are shown in Table II, expressed as reacting values. To permit a comparison of present conditions with those of 20 and 26 years ago, the results reported by Forbes and by Stabler are also given. The analytical methods used by Forbes and Stabler differed somewhat from those used by Breazeale, but it is believed that the results are fairly comparable.

Hardness Ratio—The essential feature of the quality of the salts in irrigation water lies in the relationship between alkaline-earth bases (calcium and magnesium) and the alkali bases (sodium and potassium). In the analyses made by Breazeale the alkali bases were not determined, but it is known that their quantity may be reliably estimated as the difference between the sum of the reacting values of the acids and the sum of the reacting values of the alkaline-earth bases. Thus for the first entry in Table II the sum of the reacting values of the acids (*r* acids) is given as 13.95, and the sum of the reacting values of the alkaline-earth bases is 7.76; the difference, or 6.19, may be taken as the reacting value of the alkali bases. For convenience of expression the proportion of alkaline-earth bases to total reaction units may be expressed as percentage of "hardness." By this method of expression the percentage of hardness for the past three years is as follows: 1922-23, 56 per cent; 1923-24, 53 per cent; 1924-25, 55 per cent. By the same method the hardness in 1900 was 48 per cent and in 1905 it was 58 per cent.

With respect to industrial or domestic uses, the hardness of water is ordinarily calculated from analyses in terms of parts per million stated as calcium carbonate. If the calcium and magnesium of the Colorado River are so computed from the weighted means given in

TABLE II—CHARACTER OF DISSOLVED SALTS (Annual Means)

Period	Number of Analyses	Constituents As Reacting Values: *r* Ca	*r* Mg	*r* HCO_3	*r* Cl	*r* SO_4	*r* Acids
1922—23	47	5.65	2.11	3.20	3.32	7.43	13.95
1923—24	52	4.96	1.75	2.80	3.18	6.60	12.62
1924—25	50	5.82	2.56	3.64	3.62	7.82	15.17
1900	7[1]	3.60	1.80	3.02[2]	3.90	4.15	11.42[3]
1905	12	4.60	1.92	3.83	3.59	3.83	11.25

[1]For making complete analysis the samples collected by Forbes were made into 7 composites. [2]Reported as CO_3. [3]Includes SiO_2.

Table I, the result expressed as an average for the recent three-year period is 260 p.p.m. as $CaCO_3$. This figure may be compared with that for the hardness of the Owens River supply of Los Angeles, which is 163, and of the Los Angeles River tunnels, which is 251 as reported by W. D. Collins in Water Supply Paper 496.

It has been noted above that the salt content of the Colorado has averaged higher in recent years than in 1900 and in 1905 when it was first analyzed systematically.

The evidence in support of this view is not wholly satisfactory because the earlier samples included the discharge of the Gila River and because the total discharge at Yuma is known for only one of these early years. However, the fact remains that more water is now diverted for irrigation in the upper part of the basin, and such diversion causes an increase in the return flow of drainage and seepage water from the irrigated land. The salt content of this return flow is invariably higher than that of the water diverted, and consequently the stream below an irrigated section is saltier than it would be if a part of the water were not used. A number of the irrigated areas in the Upper Basin include tracts of salty land that are being leached and drained into the river. Each of these contributes something to the total salt content. The effect of this return flow of salty water is more noticeable in the periods of low water downstream than in the flood stages. In 1900 only 8 of the 61 samples tested showed a salt content above 1,000 p.p.m.; in 1905 only 17 of 106 samples were above that figure; while from 1923 to 1925 no less than 69 of the 149 samples showed 1,000 p.p.m. or more. In 1900 the highest salt content reported was 1,250 p.p.m.; in 1905 the highest was 1,230; while for 1923-25 there were 27 out of 149 samples in which 1,250 was exceeded. The present indications are that the trend of salt content in the river is upward rather than downward.

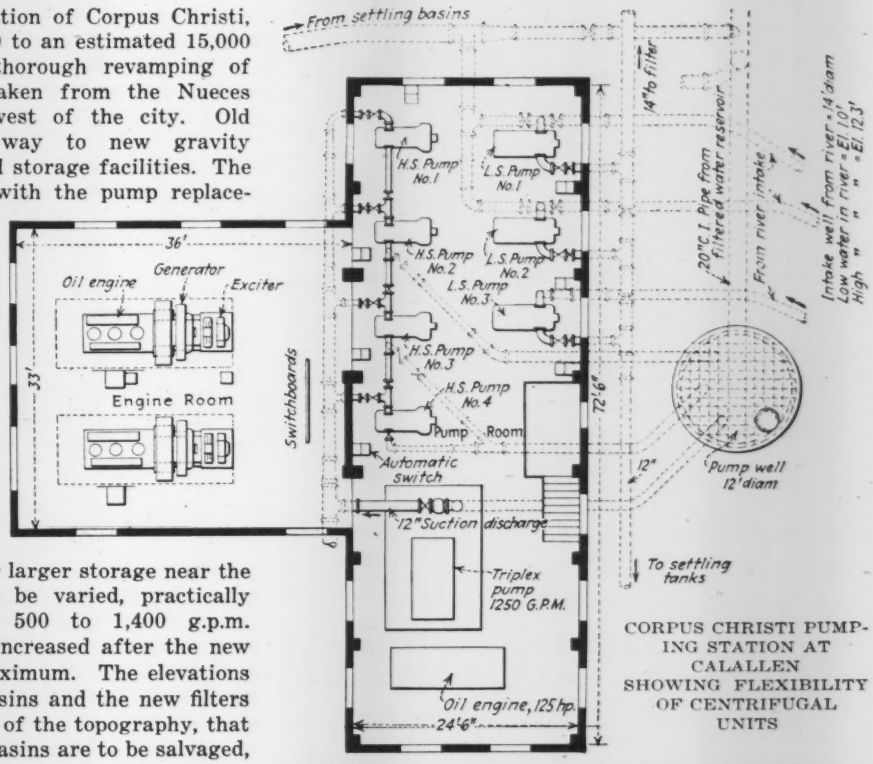
Revamping the Corpus Christi Water-Works System

Oil-Engine-Driven Generators Supply Current to Seven Motor-Driven Centrifugals Piped for Series or Parallel Operation

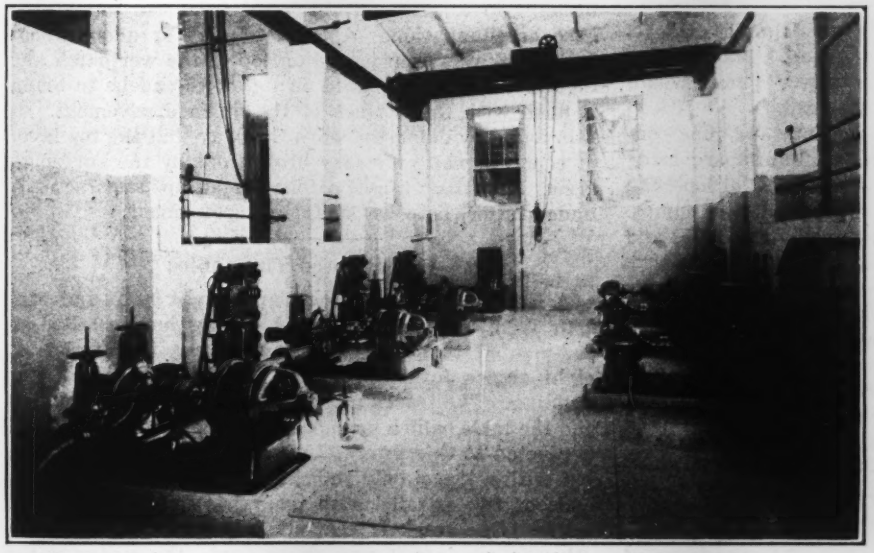
RAPID growth in the population of Corpus Christi, Texas, from 10,522 in 1920 to an estimated 15,000 now has made imperative a thorough revamping of the water supply, which is taken from the Nueces River at Calallen, 18 miles west of the city. Old pressure filters are giving way to new gravity filters with additional pump and storage facilities. The present article will deal only with the pump replacements; the filter plant and basins will not be completed until late this season. Seven motor-driven centrifugal units with the extreme of flexibility for the double and sometimes triple pumping required and an oil-engine-operated generator comprise the new installation.

The water is pumped through 80,000 ft. of 20-in. cast-iron pipe to a 250,000-gal. elevated tank in town. As no funds have been available for larger storage near the city the pumpage has had to be varied, practically with the consumption, from 500 to 1,400 g.p.m. averaging 1.5 m.g.d., recently increased after the new pumps were in to 2.5 m.g.d. maximum. The elevations of the old plant and settling basins and the new filters and clear well are such, because of the topography, that it is necessary, if the old large basins are to be salvaged, to pump from the river into them and again lift the settled water to the new filter, although under ordinary conditions of turbidity the small coagulating basins ahead of the filters give a sufficient detention period.

The old low-service pumping plant consisted of two units of 8-in. belt-driven centrifugal pumps with 20-hp. oil engines, the pumps rated at about 1,800 gal. a minute. The old high-service pumping plant, which occupied the entire floor space of the pump room, consisted of two triplex power pumps with a capacity of 500 gal. per minute direct-connected to 50-hp. oil engines, and one triplex power pump with a capacity of 1,250 g.p.m. connected to a 125-hp. oil engine. The latter was retained as an auxiliary and reserve; the two former were removed, one at a time, and replaced with centrifugal pumps without interruption of the supply.



CORPUS CHRISTI PUMPING STATION AT CALALLEN SHOWING FLEXIBILITY OF CENTRIFUGAL UNITS



CENTRIFUGALS—THREE LOW-LIFT UNITS ON RIGHT AND FOUR HIGH-LIFT ON LEFT
The high-lift units are so piped and valved that any combination of series or parallel operation can be had.

The engineer, who for several years had charge of the plant suggested the installation of electrically-operated centrifugal pumps and that oil-engine-operated generators be placed in the space occupied by the pressure filters, which were to be removed. After taking up the complex pumping proposition with local representatives of manufacturers and getting the characteristics of pumps that seemed serviceable and suitable for the conditions a tentative plan for a plant was worked out. This contemplated two-stage high-service pumps with steep characteristics; the plan was satisfactory

enough to serve as a basis on which to ask proposals, though the efficiency of the pumps over the great range of heads was lower than desired. As finally worked out, high efficiencies of the pumps were maintained by working single-stage pumps in parallel, in series, or in parallel and series, as the delivery required.

The installation consists of two 150-hp. oil engines direct-connected to 125-kva. generators, three motor-driven 8-in. 1,150-r.p.m. low-service centrifugals operating at 1,150 r.p.m., and four 5-in., 1,750-r.p.m. high-service centrifugals. The capacity of the low-service pumps is 1,400 g.p.m. against 35-ft. head, with an efficiency of 78 per cent; the efficiency remains high over a great range of delivery with corresponding heads. The connections are so made that the southern pump, No. 1, may supply the filters from either source, as may also pump 2; while the northern pump 3 was intended to supply the settling basins with raw river water, as may also pump 2 when so desired.

The top of the elevated tank is at El. +159, the bottom is approximately El. +112. The high-service pumps are operated against a static head that may vary between 94 and 154 ft. as extremes and averages 124 ft.; the total dynamic head may vary between 118 and 242 ft., according to the amount delivered, and may reach 265 ft. The delivery of these four pumps in gallons per minute and their corresponding efficiencies at heads given are:

Delivery, g.p.m.	700	1,000	1,150	1,300
Head, ft.	140	124	112	90
Efficiency, per cent	66	72	73	72

Under the operating conditions the delivery of a single pump will vary from 1,050 to 700 g.p.m. against heads varying from 118 to 140 ft. and efficiencies from 72 to 66 per cent. With two pumps in parallel the delivery is 1,480 to 1,050 g.p.m., with 138- to 147-ft. heads and 67 to 57 per cent efficiencies. Two pumps in series give 1,360 to 1,260 g.p.m., with 132- to 186-ft. heads and 70 to 72 per cent efficiencies. Four pumps in series and parallel give 2,400 to 2,080 g.p.m., with 210- to 242-ft. heads and 73 to 72 per cent efficiencies. Two pumps in series together with the 1,250-g.p.m. power pump would deliver 2,440 gal. against 214 ft. and 2,230 g.p.m. against a 254-ft. head. Four pumps in series and parallel with the power pump would deliver 3,000 g.p.m. against 265-ft. head.

The drawing shows the arrangements and pipe connections by which one or two pair of units are made to operate in parallel or series by closing or opening the valve on the connection pipe between two pumps. The plant has been in operation since July, 1925, and has proved satisfactory according to the engineers.

L. B. Griffith was city engineer at the time of the inauguration of the improvements; he was succeeded in April, 1925, by H. Levinson, who since then has been superintending the work together with the plant engineer, J. W. Cunningham. N. Werenskiold, consulting engineer, Dallas, made the original investigations and designs for all of the improvements.

Large Scale Conversion Chart

Copies of the large scale chart for converting Kutter's *n* into Hazen and Williams' *C*, described in our issue of July 8, p. 73, will not be ready for distribution until about Aug. 1.

Patching Pavement Cuts by Contract in Albuquerque

IN filling pavement cuts for utilities an unusual combination of force account and contract work has been adopted in Albuquerque, N. Mex. Briefly, the city forces fill the cuts as they are made temporarily with concrete laid as base and surfacing, or in two layers, then when a hundred or so cuts have accumulated a contract is let for removing the concrete top layer and substituting bitulithic to correspond with the rest of the pavement. As explained by City Engineer Frank Kimball, the city of Albuquerque has only two types of paving, black base 3 in. and concrete 5 in., each with a 2-in. Warrenite bitulithic surface. Warren Brothers have a local representative in the New Mexico Construction Co., and to date this company has done most of the paving in the city.

The usual paving "year" is from four to six months and it has been found that during the remainder of the year approximately a constant number of paving cuts have been made. The procedure followed for a long period of time was to have the local representative of Warren Brothers patch all cuts in the city about once each month. However, it was found to be a costly method if there was no paving being laid at that time, as it meant firing up the asphalt plant and calling in skilled labor to do this work. After paying out considerable money for this sort of work, it was decided to have the city forces do all patch work, using concrete, and then after the accumulation of an hundred or more such patches to have the Warrenite surface placed on them under one order.

It was found, when the surfacing crew chipped out the top 2 in. of concrete preparatory to placing the patch, that it required considerable labor, so in order to cut down the expense and to speed up the work another method was resorted to. After the paving cut had been prepared to receive the concrete by the city forces, by excavating 6 in. below the base of the paving and 6 to 12 in. underneath the paving surrounding the cut, the concrete patch was placed in this opening and brought to a point within ½ in. from the top of the base or foundation. A layer of dirt or adobe about ½ in. thick was then placed on top of the wet patch and then more concrete placed on top of the adobe to bring it flush with the surface of the finished pavement. It was found by doing the work this way that the top layer of concrete was very easy broken out by the surfacing crew, and that these patches held up satisfactorily under traffic, between surfacing operations.

End-Pivoted Turntables

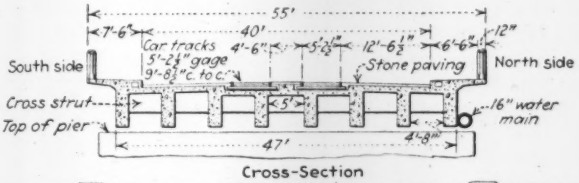
A French manufacturing plant served by an industry spur from the French State Railways has installed an end-pivoted turntable to transfer cars to a track at right angles to the spur and passing through a shop building. The tracks intersect just outside the building and the table, which swings through an angle of 90 deg., is pivoted at this intersection. A similar arrangement, but with a travel only sufficient to serve the converging ends of two parallel stub tracks, is used at a freight house. One track is kept straight and the end of the other is run into it at a slight angle, the center of the pivot being at the intersection of the two center lines of the tracks.

Concrete Girder Bridge Has Steel Pin Bearings

Settlement of Substructure Allowed for by Shoe-Pin Bearings Under Ends of Girders of Deck Spans

PIN-BEARINGS were provided under the concrete girders of Mitchell Ave. bridge, in Cincinnati, Ohio, to insure uniform bearing of the spans in the event of slight settlement of the substructure. The bridge, which crosses Mill Creek, has three 54-ft. deck spans, of total width of 55 ft., for 40-ft. roadway. Cypress piles 35 ft. long, driven in a bed of stiff sandy blue clay, 50 to 60 ft. deep, support the footings of the two abutments and two piers, these footings being about 9 ft. below ordinary water level.

Each span has eight reinforced-concrete girders, 21 in. wide and 53 in. deep (exclusive of the 8-in. roadway slab), spaced 6 ft. 5 in. to 6 ft. 9 in., and the slab is cantilevered beyond the outer girders to form part of the sidewalk. Live-loads assumed for the roadway include a 20-ton truck plus 46 per cent impact for the slab and 25 per cent impact for the beams; also a 52-ton street car plus 10 per cent impact. For the sidewalk, the live-load is taken as 200 lb. and 50 lb. per square foot for the slab and beams respectively.



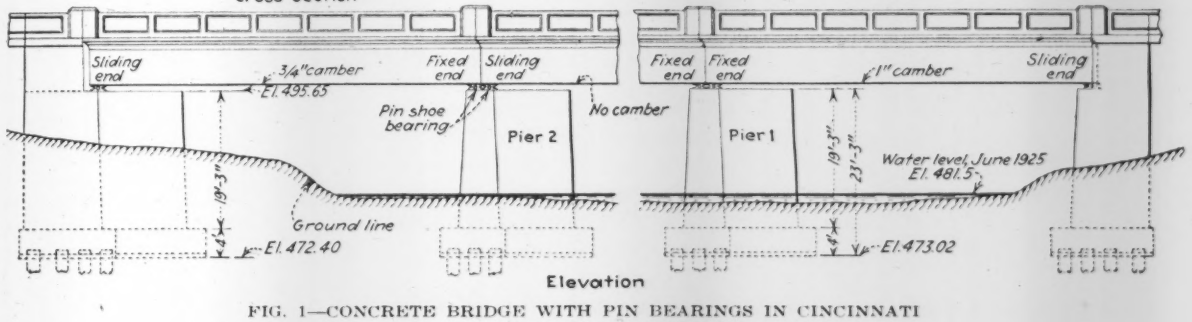


FIG. 1—CONCRETE BRIDGE WITH PIN BEARINGS IN CINCINNATI
Note water main along outside girder.

On account of the possibility of slight settlement it was decided to use steel shoe-pin bearings for the spans, placing a bearing at each end of each girder. With the ordinary form of construction, having girders seated directly on the piers and abutments, if any settlement occurs the entire load is concentrated at the edge of the bridge seat or at the end edge of the girder, and is thus likely to cause cracks or spalling. With the pin bearings this action will be avoided and the load will in any case come upon the bearing pins. Each of the 48 bearings consists of two steel castings and a 4⅜-in. steel pin 21 in. long, with ½-in. space between the two castings. The lower casting rests on the bridge seat, while the upper casting is anchored to the bottom of the girder. Half of the bearings will be fixed, the bottom castings resting directly on the piers and abutments and each being anchored by four 1-in. bolts 18 in. long. The other bearings, with sliding seats, will provide for expansion by having slotted holes for the anchor bolts; under the bottom shoe will be a 1-in. steel plate covered with a ⅛-in. copper sheet upon which the shoe can slide. In all the bearings the upper casting will be anchored to the concrete girder by four ⅞-in. bolts, 18 in. long.

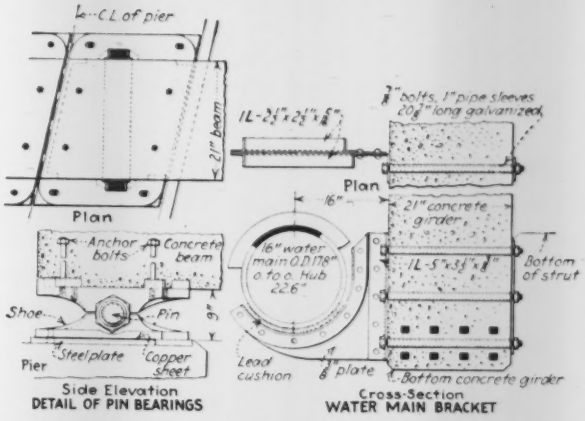


FIG. 2—DETAIL OF PIN BEARING AND BRACKETS FOR WATER MAIN ON BRIDGE GIRDER

Another feature of this structure is the provision for carrying a 16-in. water main by means of structural steel brackets anchored to the face of the outer girders and spaced about 8 ft. apart. With this arrangement the pipes can be set in place easily by means of slings over the parapet, and the main will be accessible for repairs. If the main had been placed under the floor, its construction would have been difficult and expensive, and it would have been difficult of access for repairs.

This bridge, now being built by the United Construction Co., Cincinnati, was designed by the engineers of the city's Bureau of Highways.

Pontchartrain Not Part of Gulf of Mexico

An inquiry was recently made of the War Department asking if Lake Pontchartrain should be regarded as an arm of the Gulf of Mexico across which a bridge could be constructed only by authority of Congress. The Secretary of War has replied that the Department regards Lake Pontchartrain as a body of water distinct and separate from the Gulf of Mexico, and as a waterway of which the navigable portions lie wholly within the limits of Louisiana. Therefore, if it is desired to construct a bridge across this lake the applicant need only secure a permit from the War Department, based upon State authority and the suitability of the plans from the standpoint of navigation.

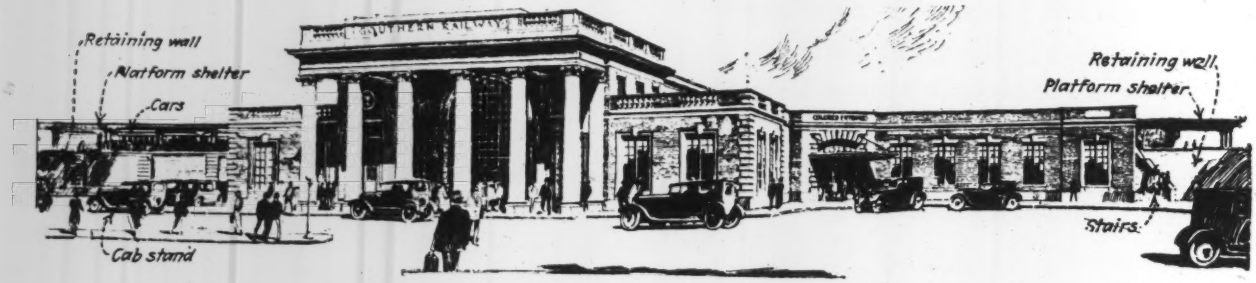


FIG. 1—NEW STATION AT GREENSBORO, N. C.

Union Station on the Southern Ry. at Greensboro, N. C.

Main Floor at Street Level with Subway to Platforms—Separate Baggage and Express Buildings—Revised Track Plan—Grade Separation with Steel Bridges Over Streets

IMPROVEMENTS now under construction by the Southern Railway at Greensboro, N. C., a manufacturing city of about 45,000 population, include a new passenger station and a rearrangement of tracks, with the elimination of two grade crossings by means of street subways.

This city is an important point on the Southern Railway System, being on the double-track main line from Washington to Atlanta, as well as a junction point for a line east to Goldsboro and Norfolk, and another line west to Winston-Salem and Asheville. In addition it is the main point on the Atlantic & Yadkin Ry., which will have joint use of the new station. The passenger traffic for the Southern Ry. averages 34 trains per day, including both directions, and 20 of these are through trains. The Atlantic & Yadkin Ry. has eight passenger trains daily, of which four are through trains. A sketch of the station as it will appear when completed is given in Fig. 1, and a general plan of the tracks and station is shown in Fig. 2.

Station Layout—The old passenger station was west of Elm St., as shown by the general plan, but the new site is further east and has a better location with a frontage on Washington St., one of the main thoroughfares. The new station includes the headhouse proper, and a one-story extension 39x165½ ft. for the baggage and mail departments, beyond which is a two-story express building, 50x172½ ft. The main floor of the station is at street level, but as the tracks are about 14 ft. higher, the baggage and express floors are at the latter level. On the street side of these accessory buildings is a broad driveway 10 ft. above Washington St., and reached by an approach of 0.6 per cent grade from Eckels St.

A double-track main line opens out from the north and west into eight station tracks, two of which are for freight, while the six passenger tracks are served by three island platforms 700 to 1,200 ft. long. A single-track line from Goldsboro comes in from the east, but is south of the main tracks, so that westbound trains on this line run past the station to a switch near the Elm-Davie St. subway, Fig. 2, and are then backed eastward into the station. A manufacturing plant in the angle between the two lines made it impracticable to connect the Goldsboro line with the east end of the station layout.

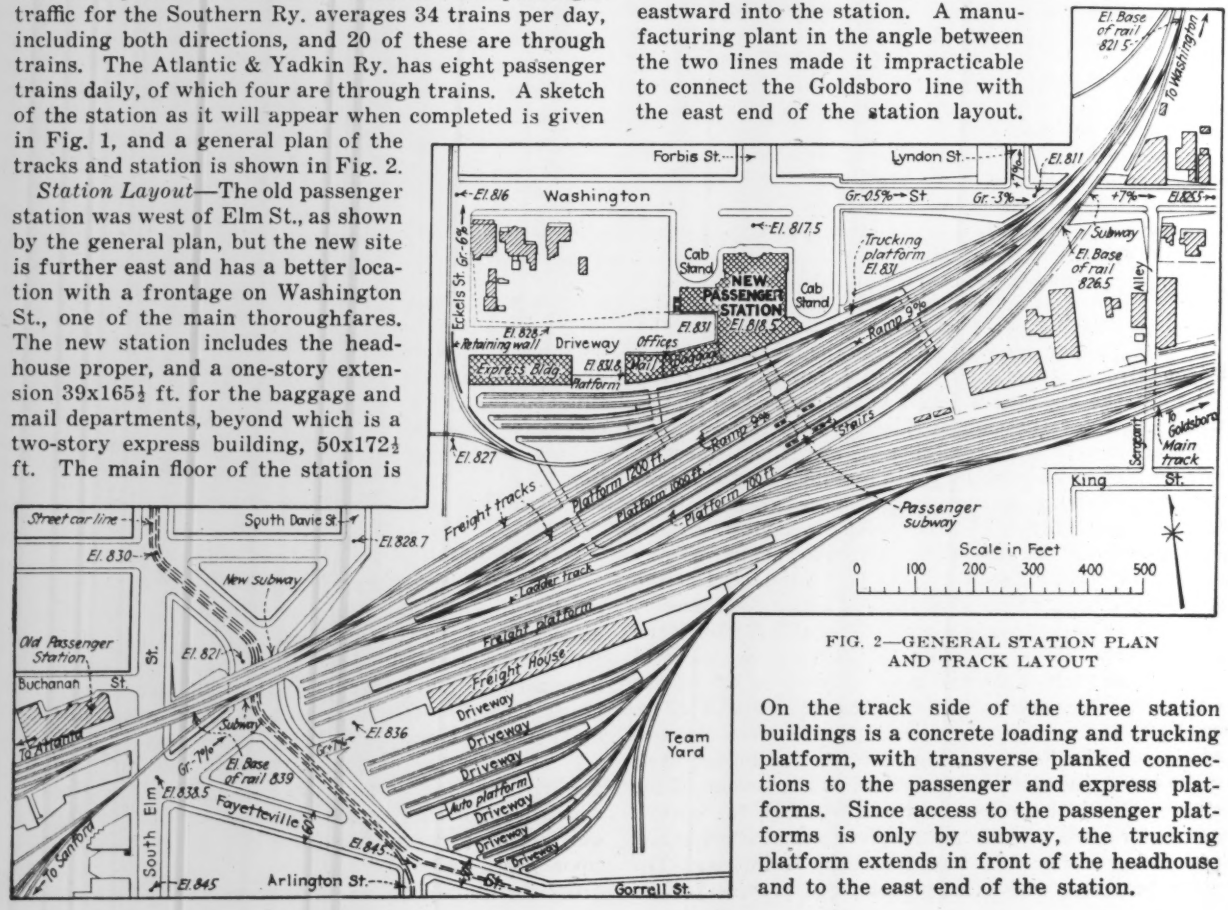


FIG. 2—GENERAL STATION PLAN AND TRACK LAYOUT

On the track side of the three station buildings is a concrete loading and trucking platform, with transverse planked connections to the passenger and express platforms. Since access to the passenger platforms is only by subway, the trucking platform extends in front of the headhouse and to the east end of the station.

Tracks and Platforms—For passenger service, a 22-ft. platform serves the northbound and southbound main tracks and there are also two 17-ft. platforms. The six passenger tracks, mainly on tangent and accommodating trains of nine to sixteen cars, are spaced 13 ft. c. to c., except that the spacing is 27 ft. at the two 17-ft. platforms and 32 ft. at the wider platform. South of the express tracks are industry spurs with curves of 200-ft. radius leading north along Eckels St., and west into industry plants. Two stub tracks east of the station, and on the Washington St. side, are for special cars and dining cars. On the opposite side of the main tracks are two stub tracks interrupted by the Washington St. subway approach; these are used

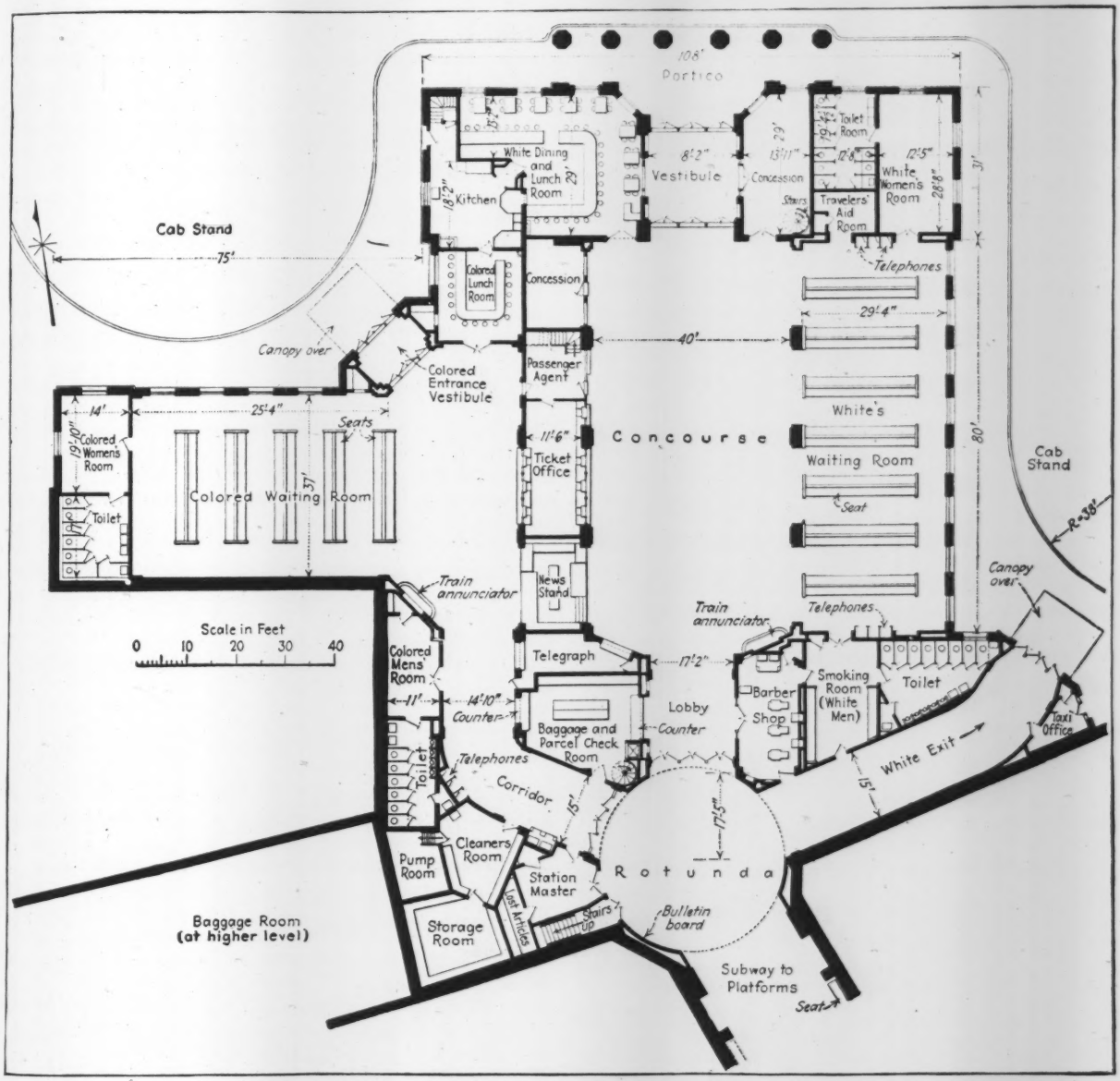


FIG. 3—PLAN OF MAIN FLOOR OF HEADHOUSE

All platforms are 6 in. above rail level and are paved with concrete. They are lighted by electric lamps placed about 20 ft. apart. Platform shelters of the butterfly type, 132 to 832 ft. long, have steel columns and purlins, with wood sheathing.

From the inner station track diverge five tracks, the first of which, adjacent to the station buildings, serves for baggage, mail and express cars. The others, with a total capacity of 26 express cars, are spaced alternately 13 and 25 ft. c. to c., with concrete platforms in the wider spacings. Planked runways across the tracks connect the trucking platforms with the passenger platforms. for industrial purposes. South of the station tracks are the freight yard and team yard.

Changes from the original grade of tracks are only slight, giving a raise of about 3 ft. at the Elm-Davie St. subway and 1 ft. at the Washington St. subway. From the west there is an ascending grade of 0.5 per cent to the former subway, then descending 1 per cent to the station, 0.3 per cent through the station and again descending 1 per cent over Washington St. until it strikes the original grade. Main tracks are laid with 100-lb. rails and the station tracks have 85-lb. rails on untreated ties in stone ballast. Only easy curves are

required, with a maximum of 9 deg. 14 min. for the passenger tracks and 7 deg. for freight main tracks, but some of the industry spurs have curves as sharp as 200-ft. radius. Frogs of No. 10 and No. 12 are used in main tracks and No. 8 in yards, but with some No. 6

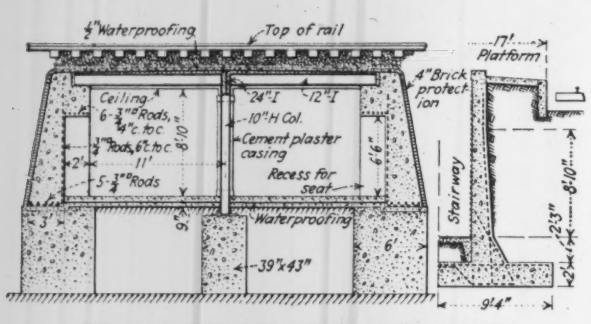


FIG. 4—PASSENGER SUBWAY TO TRACKS

frogs in industry connections. No diamond or slip switches are included. Main track switches are connected with the automatic signal system, but there is no interlocking plant. A drainage system for the elevated tracks will be developed later.

Station Headhouse—This building, Figs. 1 and 3, about 125x175 ft., is one story high, with a clerestory or monitor roof over the concourse. All station facilities are on the main floor, at street level, while space for trainmen's rest rooms and locker rooms is at track level. At one side is a wing about 40x68 ft. The exterior finish is of brick with stone trim, a row of tall columns forming a portico on the street side. The station has a conspicuous location, being set back from the street and having an open space on each side. The appearance from Washington St. is somewhat unusual, since the baggage annex and express building are at a higher elevation than the headhouse, as already explained.

Since the station is located in a southern state which requires separate accommodation for colored people, the interior arrangement differs considerably from that of northern stations, as will be seen by Fig. 3. Thus, the small wing, containing waiting and toilet rooms for colored people, is served by a separate cabstand and has a separate concourse leading to the passenger subway.

In the main part of the building a vestibule 18 ft. wide leads from the entrance portico into a concourse about 40x80 ft., which is flanked on one side by the waiting room and on the opposite side by the ticket office and other facilities. Dining rooms and toilet rooms flank the entrance vestibule. From the concourse a second vestibule leads into a rotunda, which has the passenger subway opposite and the colored and exit concourses on either side.

Passenger Subway—From the main floor of the station a subway 22 ft. wide and 8 ft. 10 in. high extends under the tracks. This subway, Figs. 4 and 5, is connected with the first passenger platform by a ramp of 9 per cent grade and a stairway, while access to the other platforms is by stairways. Gates and ticket inspectors' railings are provided at the subway entrances to the platforms. A ramp is used at the first platform, since this is the most important, serving both northbound and southbound main-line trains. The other two platforms serve less important tracks. A broad passage connects the station concourse with the subway, but a lateral concourse enables passengers to reach the street or enter the subway without passing through the station.

This subway is of steel and reinforced-concrete

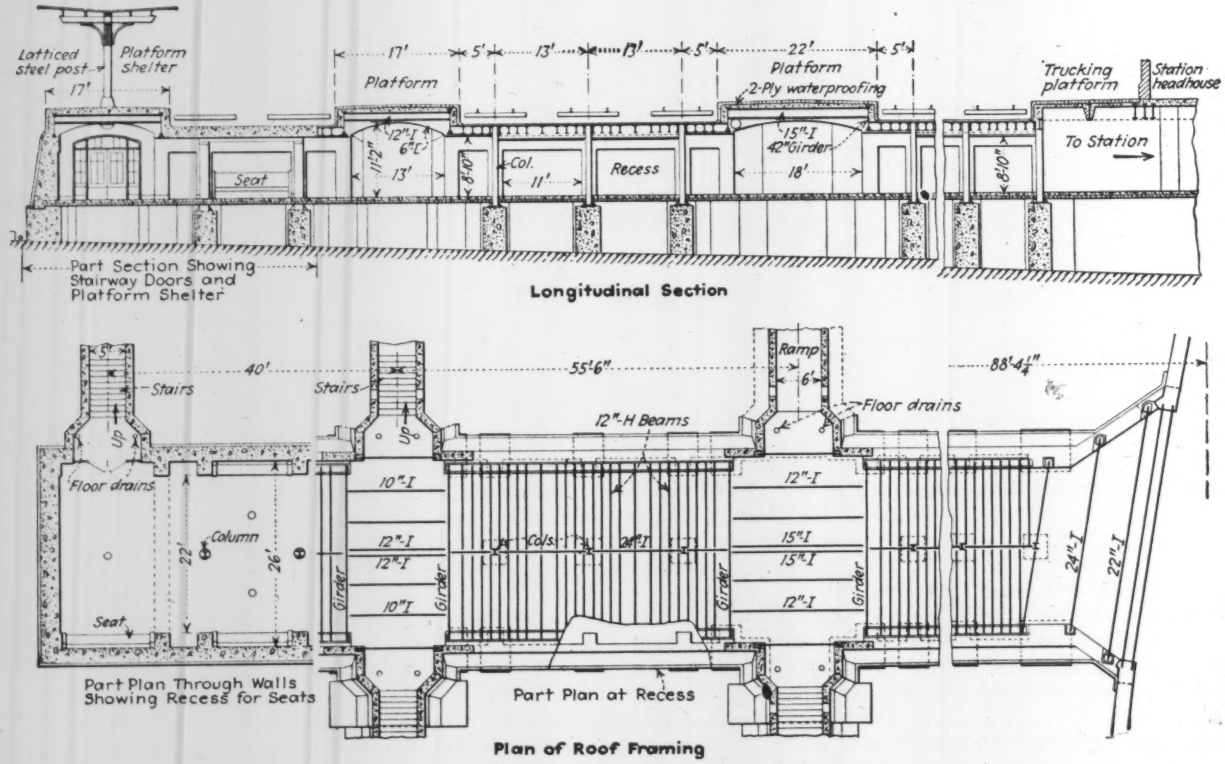


FIG. 5—GENERAL PLAN OF PASSENGER SUBWAY

construction, with concrete side walls and a central row of steel columns carrying a steel roof framing on which is a concrete slab deck for the tracks and platforms. Ballast is laid directly on the slab. Recesses in the side walls are fitted with bench seats. These walls and a suspended ceiling are faced with sand-finish cement plaster, and similar plaster is used for the ornamental casing of the columns. Ceiling lights are spaced 13 ft. c. to c. The walls are carried down below the subway floor to a foundation on rock, and the central columns are seated on concrete pedestals also

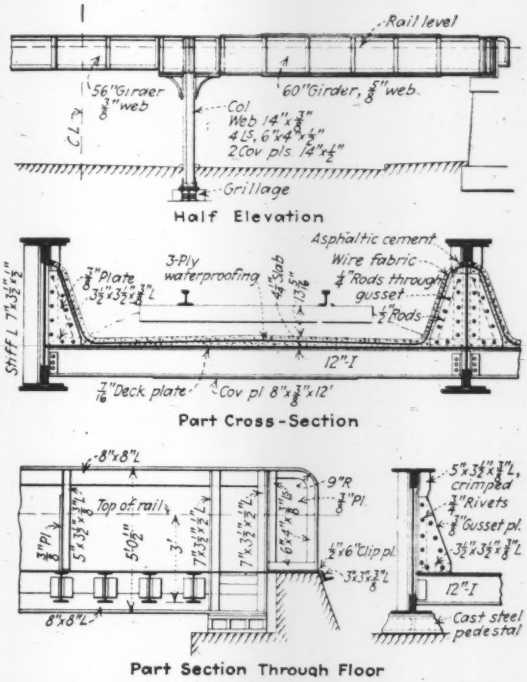


FIG. 6—ELM-DAVIE ST. SUBWAY BRIDGE

founded on the rock. A heavy floor slab is extended upward as the base of the concrete steps, which have undercut 7⅞-in. risers and 10-in. treads with non-slip edging. In addition to a waterproofing membrane on the outside of the concrete there is a waterproof coating on the inside, while a drainage system takes care of any water that may enter.

Steel framing for the subway consists of a row of 10-in. H-columns which carry a central line of 24-in. I-beams. Transverse 12-in. H-beams of variable spacing are secured to the web of the longitudinal girder and have their outer ends seated on the side walls. To carry the train platforms, there are plate girders spanning the entire width of the subway and having framed between them the H-beams on which the concrete platform slab is placed. With this girder arrangement, columns are kept at a distance from the ramp and stairway openings on each side of the subway.

Street Subways—With the tracks raised only slightly above the original grade and at an elevation of 9 to 10 ft. above street level, it was necessary to depress the streets for the two subways near the station, Fig. 2. As the territory is not closely built up, it was possible to provide for this mainly by cuts with side slopes of 1 on 1½, which are turfed and seeded. The railway tracks also are on open fills with side slopes instead of retaining walls. The streets in the subways are paved with durax stone blocks on grades of 7 per cent and with asphalt on lighter grades. They have concrete sidewalks.

At Washington St., which has no street-car tracks, the depression is about 6 ft., with an approach grade of 0.5 per cent on the west. On the east side, avoidance of certain property made it necessary to use a short approach with 7 per cent grade. This subway has a clear minimum headroom of 12 ft. 6 in., with 15½ ft. from street paving to base of rail. The tracks are carried by a through plate-girder bridge of two spans, with a central pier, and in order to introduce a shallow floor system there are four lines of girders for the three-track structure.

Elm-Davie St. Subway—At the west end of the station, a street diversion enables one subway with 76½-ft. roadway and two 10-ft. sidewalks to serve two streets on each side of the railway by means of Y-approaches having grades of 2.7 to 7 per cent. As this subway has a double track street-car line it has a minimum clear headroom of 13 ft. 6 in. over car tracks to provide for the trolley wires and supports, while the minimum headway over roadways is 12 ft. 6 in. The distance from street paving to base of rail is about 18 ft. The bridge construction is similar to that at Washington St., except that it is 96½ ft. long between abutments and has three spans with two piers in the roadway. This subway eliminates a former grade crossing of street-car and railway tracks on South Elm St.

For this skew crossing with three tracks, the construction of which is shown in Fig. 6, the bridge has four lines of through girders over the three spans. The girders are spaced 14½ ft c. to c., except that at one end one of the outer girders is flared away in order to provide for a curve in the track. The side spans are about 42 and 44 ft., with a 30-ft. middle span, there being two lines of columns in the roadway, with the street railway tracks between them.

These columns are 14-in. I-section, built up of a web plate, four angles and two cover plates over the angles. Knee braces extend to the girders. For the deck, 12-in. H-beams with 18-in. spacing are secured to connection angles on the girder webs and are covered with a ⅞-in. steel deck plate. Upon the plate is a reinforced-concrete slab with waterproofing membrane. This concrete is carried up to enclose the gusset plates and form a trough for the stone ballast. Ornamental paneling will be attached to the fascia girders, which will be surmounted by a railing and a panel containing the name of the railway.

Street Approaches—In connection with the new station, some important improvements are being made by the city in widening several streets which form approaches. Washington St., on which the station fronts, is to be widened 20 ft. to a total of 65 ft. between building lines, with a 45-ft. roadway. Forbis St., which terminates opposite the station, is to be widened 15 ft. to a total of 70 ft. between building lines, with a 50-ft. roadway.

Architects and Engineers—The architects for the station building are Fellheimer & Wagoner, of New York, and the general contractor is the Consolidated Engineering Co., Baltimore, Md. B. Herman is chief engineer of the Southern Railway System. Construction was commenced in March, 1926, and it is expected to have the station ready for service by March, 1927.

Theoretical Energy Losses in Intersecting Pipes

Confined to Impact and Eddies—General Formula Deduced, with Application to a Number of Particular Cases

By J. C. Stevens
Of Stevens & Koon, Consulting Engineers, Portland, Ore.

When a number of pipes, each carrying a flow of water under pressure, intersect in a common point and the water flows away in a main, the energy loss may be determined from the principles of the conservation of momentum and energy. A common example is that of water flowing from a branch into a main through a T. Another is that of several pumps discharging into a common header.

All intersections herein treated are assumed to be without curvature. Standard T, crosses, Ys distributing headers, side outlet elbows, and Ts do not have sufficient curvature to reduce the losses materially over those shown herein. A corollary from the analysis presented herein is that the direction of flow through a junction is theoretically immaterial in the case of symmetrical flows. The losses are the same whether flowing from branches to a main or from the main to branches. The losses herein considered are those due to impact and eddies. Losses due to pipe friction are not considered. In practice friction losses in such short stretches of pipe under consideration may be safely neglected. The following notation is used:

$(1), (2), —(n)$ = designation of branches
$q_1, q_2, —q_n$ = flow in the respective branches
$a_1, a_2, —a_n$ = areas of branches
$v_1, v_2, —v_n$ = velocities in branches
$h_1, h_2, —h_n$ = velocity heads in branches
$\theta_1, \theta_2, —\theta_n$ = angle each branch makes with the main
Q = flow in main $= q_1 + q_2 \ldots\ldots + q_n$
A = area of the main
V = velocity in main
H = velocity head in main
P = maximum average pressure in main below the junction
J = pressure at the junction
i = energy lost by impact and eddies expressed as a head, for brevity called the eddy loss.

General Formula—Wherever two or more pipes join at a common point, the pressure at the junction is equal; hence the momentum equation, in which change of pressure equals change of momentum, may be written

$$(J-P)A = \frac{Q}{g}V - \left(\frac{q_1}{g}v_1\cos\theta_1 + \frac{q_2}{g}v_2\cos\theta_2 \ldots + \frac{q_n}{g}v_n\cos\theta_n\right) \quad (1)$$

Utilizing the relations:

$$V = \frac{Q}{A} \text{ and } h_n = \frac{1}{2g}\left(\frac{q_n}{g_n}\right)^2$$

we find the drop in pressure as the water passes the junction to be

$$J - P = 2H - 2h_1\frac{a_1}{A}\cos\theta_1 - 2h_2\frac{a_2}{A}\cos\theta_2 \ldots - 2h_n\frac{a_n}{A}\cos\theta_n \quad (2)$$

The energy loss is expressed by the difference in energy which the water possesses before and after passing the junction, thus:

$$Qi = q_1(J+h_1) + q_2(J+h_2) \ldots + q_n(J+h_n) - Q(P+H) \quad (3)$$

whence the energy head lost is

$$i = J - P - H + \frac{q_1}{Q}h_1 + \frac{q_2}{Q}h_2 \ldots + \frac{q_n}{Q}h_n \quad (4)$$

Substitute for $J-P$ its value from (2) and (4) becomes

$$i = H + h_1\left(\frac{q_1}{Q} - 2\frac{a_1}{A}\cos\theta_1\right) + h_2\left(\frac{q_2}{Q} - 2\frac{a_2}{A}\cos\theta_2\right) \ldots + h_n\left(\frac{q_n}{Q} - 2\frac{a_n}{A}\cos\theta_n\right) \quad (5)$$

Equation 5 is a general expression for the lost energy head for any number of intersecting pipes of any variety of sizes and angles of intersection.

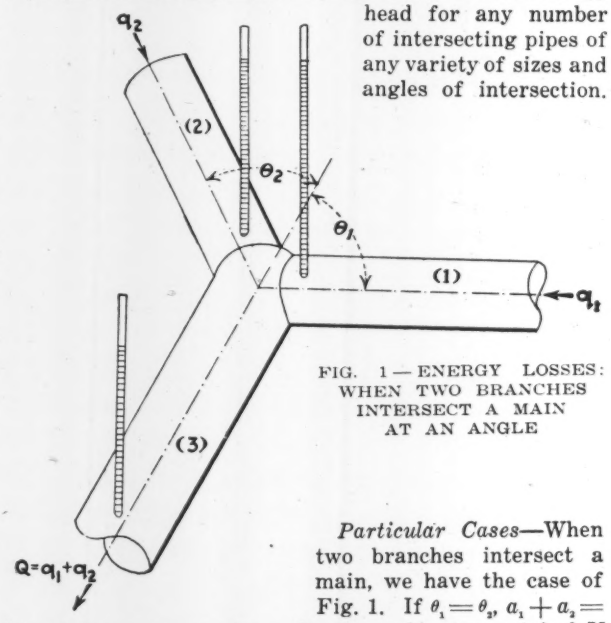


FIG. 1—ENERGY LOSSES: WHEN TWO BRANCHES INTERSECT A MAIN AT AN ANGLE

Particular Cases—When two branches intersect a main, we have the case of Fig. 1. If $\theta_1 = \theta_2$, $a_1 + a_2 = A$, and $q_1 = q_2$ we have the case of a symmetrical Y in which there is no change of velocity. Yet the eddy loss is

$$i = 2h(1 - \cos\theta) \quad (6)$$

where h is the common velocity head and θ is half the angle of spread. When $\theta = 90$ deg. we have the case of a right-angle bend in a uniform-sized pipe or that of a T in which the area of each branch is half that of the main. It matters not whether the branches are in the same plane or whether all three pipes are at right angles to each other; nor does it matter in which direction the water is flowing—the loss in either case is twice the velocity head. These conclusions are also true of any number of branches intersecting at right angles, like the spokes of a wheel to the main. The loss is twice the common velocity head, if there is no change of velocity between branches and main. For example, water at a velocity of 10 ft. per sec. passes through a standard T with one end plugged to form an elbow, a common practice. The loss is theoretically 3.1 ft. of head.

In equation 5 let all angles of intersection be zero. Call the sum of the areas of the branches na and the common velocity head h. Then if na is less than A, we have the case of a sudden enlargement, and if na is greater than A, we have a sudden contraction, which is of course the same as reversed flow in an enlargement. In this particular case equation 5 reduces to

$$i = H + h\left(1 - 2\frac{na}{A}\right) \qquad (7)$$

let

$$z = \frac{na}{A} = \frac{V}{v} = \sqrt{\frac{H}{h}}$$

and equation 7 becomes

$$i = h(1 - z)^2 \qquad (8)$$

Obviously it matters not whether z is greater or less than 1, the loss is always positive. Theoretically, therefore, the loss in a sudden contraction or a sudden enlargement is the same for the same change of area. When $z = 1$, there is no change in the size of pipe and the loss is zero.

Equation 8 is readily transformed into the well-known formula for the lost head in a sudden enlargement (see Merriman's "Hydraulics") thus

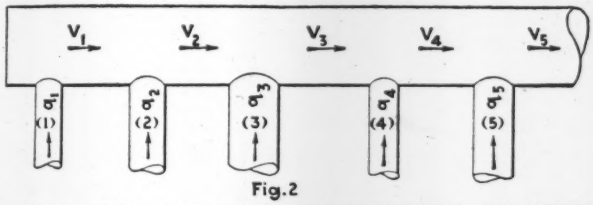


Fig. 2

FIG. 2 — ENERGY LOSSES: WHEN SEVERAL BRANCHES INTERSECT A MAIN AT RIGHT ANGLES TO IT

$$i = \frac{v^2}{2g}\left(1 - \frac{V}{v}\right) = \frac{(v - V)^2}{2g} \qquad (9)$$

The validity of this formula was established by the experiments of W. H. Archer (*Trans.*, Am. Soc. C. E., Vol. LXXVI, p. 999, 1913) at the hydraulic laboratory of the University of California in 1912. When we consider that in these formulas we are dealing with mean velocities only and that the actual kinetic energy of the water is

$$\int \frac{u^2}{2g}\, du$$

where u is the velocity of each individual particle, instead of

$$\frac{V^2}{2g}$$

where V is the mean velocity in the pipe, it is not surprising that Archer found the coefficient B in the formula

$$i = B\,\frac{(v - V)^2}{2g}$$

to vary from 0.75 to 1.2, depending on the initial velocity v and the ratio of areas. He found that the formula

$$i = 1.098\,\frac{(v - V)^{1.919}}{2g}$$

more accurately expressed the eddy losses for the sizes of pipes used—1 to 3 in. in diameter.

A particularly interesting case arises when a number of pumps discharge into a common header as in Fig. 2. Using the previous notation for the branches, let the following apply to the header:

A = area, assumed to be of uniform size
$V_1, V_2 \ldots V_n$ = velocities between branches
$H_1, H_2 \ldots H_n$ = velocity heads between branches
I = total eddy loss in the header

We then have the following relations:

$$V_1 = \frac{q_1}{A} \text{ and } H_1 = \frac{q_1^2}{2gA^2} \qquad (10)$$

$$V_2 = \frac{q_1 + q_2}{A} \text{ and } H_2 = \frac{(q_1 + q_2)^2}{2gA^2} \qquad (11)$$

$$V_n = \frac{q_1 + q_2 \ldots + q_n}{A} \text{ and } H_n = \frac{(q_1 + q_2 \ldots + q_n)^2}{2gA^2} \qquad (12)$$

At junction (1) we have a right-angle bend, the pipe being of different sizes. Hence from (5), since $n = 1$ and $\theta = 90$ deg.,

$$i_1 = H_1 + h_1 \qquad (13)$$

At junction (2) we have 3 intersecting pipes; (1) at an angle of $\theta_1 = 0$ carrying a flow of q_1 and (2) at an angle of $\theta_2 = 90$ deg. carrying a flow of q_2 and (3) the main carrying $q_1 + q_2$ sec.-ft. Hence

$$i_2 = H_2 + H_1\left(\frac{q_1}{q_1 + q_2} - 2\right) + h_2\,\frac{q_2}{q_1 + q_2} \qquad (14)$$

At any other junction except the first we have

$$i_n = H_n + H_{n-1}\left(\frac{q_1 + q_2 \ldots + q_{n-1}}{q_1 + q_2 \ldots + q_n} - 2\right) + h_n\,\frac{q_n}{q_1 + q_2 \ldots + q_n} \qquad (15)$$

The total loss in the header is the sum of the losses at each junction, which may be shown to be

$$I = H_n + h_1 + (h_2 - H_1)\,\frac{q_2}{q_1 + q_2} + (h_3 - H_2)\,\frac{q_3}{q_1 + q_2 + q_3} \ldots + (h_{n-1} - H_{n-2})\,\frac{q_n}{q_1 + q_2 + q_3 \ldots + q_n} \qquad (16)$$

Through the relations in equations (10 to 12) all velocity heads may be expressed in terms of the initial velocity head. Thus the relations

$$H_n = \frac{q_1 + q_2 \ldots + q_n}{q_1}\,H_1 \qquad (17)$$

also

$$h_n = \left(\frac{q_n a_1}{q_1 a_n}\right)^2 h_1 \qquad (18)$$

substituted in (16) gives

$$I = h_1\left[1 + \left(\frac{q_2 a_1}{q_1 a_2}\right)^2 \frac{q_2}{q_1 + q_2} \ldots + \left(\frac{q_n a_1}{q_1 a_n}\right)^2 \frac{q_n}{q_1 + q_2 \ldots + q_n}\right] + H_1\left[\left(\frac{q_1 + q_2 \ldots + q_n}{q_1}\right)^2 - \frac{q_1}{q_1 + q_2} \ldots - \left(\frac{q_1 + q_2 \ldots + q_{n-1}}{q_1}\right)^2 \frac{q_n}{q_1 + q_2 \ldots + q_n}\right] \qquad (19)$$

When the branches are all of the same size and each discharges the same amount into the header, equation (19) reduces to

$$I = h\left(1 + \frac{1}{2} + \frac{1}{3} \ldots + \frac{1}{n}\right) + H_1\left(n^2 - \frac{1}{2} - \frac{4}{3} \ldots - \frac{(n-1)^2}{n}\right) \qquad (20)$$

As an example, suppose five pumps discharge into a header at a uniform velocity of 10 ft. per sec. and that the initial header velocity is 2 ft. per sec. The total eddy loss in the header amounts to 4.65 ft. In low-lift pumps, such as are used for rice irrigation, this may be a major portion of the total head, and such an arrangement should be studiously avoided.

Alaska R.R. Finances Improve

A reduction of $394,692 in the deficit of the Alaska R.R. was effected during the first nine months of the current fiscal year, according to a report of the Interior Department, which shows that the deficit for this period in the fiscal year of 1926 was $611,608 as compared with $1,006,300 for the same period of 1925. An increase in the operating earnings amounting to $107,901 occurred during the first nine months of the year and operating expenses were reduced by $286,791.

New York's Third Subway Under Construction

Organization Directing Construction Charted—Theory of Engineering Control Explained—Safeguarding Street Service and Integrity of Buildings—Protecting Public Against Hazard

Continuing a series of articles on rapid-transit subway construction now in progress in New York, where a complete new network of lines is being added to those built in 1900-1904 and 1913-1918. The first article, June 17, 1926, p. 970, outlined the planning of the new third system and the history of the three successive systems with development of design and special features.

CONSTRUCTION of the third subway system for New York, planned to cost $400,000,000 and described in *Engineering News-Record*, June 17, 1926, p. 970, is actively proceeding on 10.46 miles of line. This is the Eighth Ave.-Washington Heights line and the portion actually under contract extends from Greenwich Ave. (at about 7th Ave. and 11th St.) to 212th St. The contract sections, contract prices and contractor for each section are given by the line map, Fig. 1. Summarized, 22 contracts have been awarded to 15 contractors. The total amount of the contracts is $94,578,259; the largest amount to one contractor is $13,555,871, but three other firms have contracts adding up to over $10,000,000 each. Omitting the two small contracts aggregating $368,456, for special sections, the average contract amount is $4,710,490. The average contract price per mile of line is $9,041,899. This contract price includes all construction except track (rails, ties and ballast) and station finish.

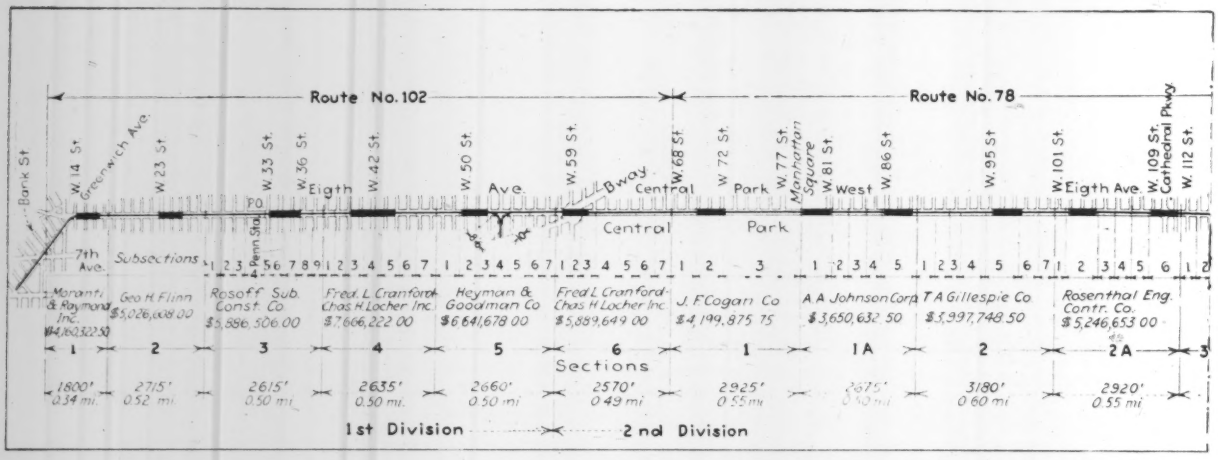


FIG. 1—EIGHTH AVE.-WASHINGTON HEIGHTS LINE MAP SHOWING

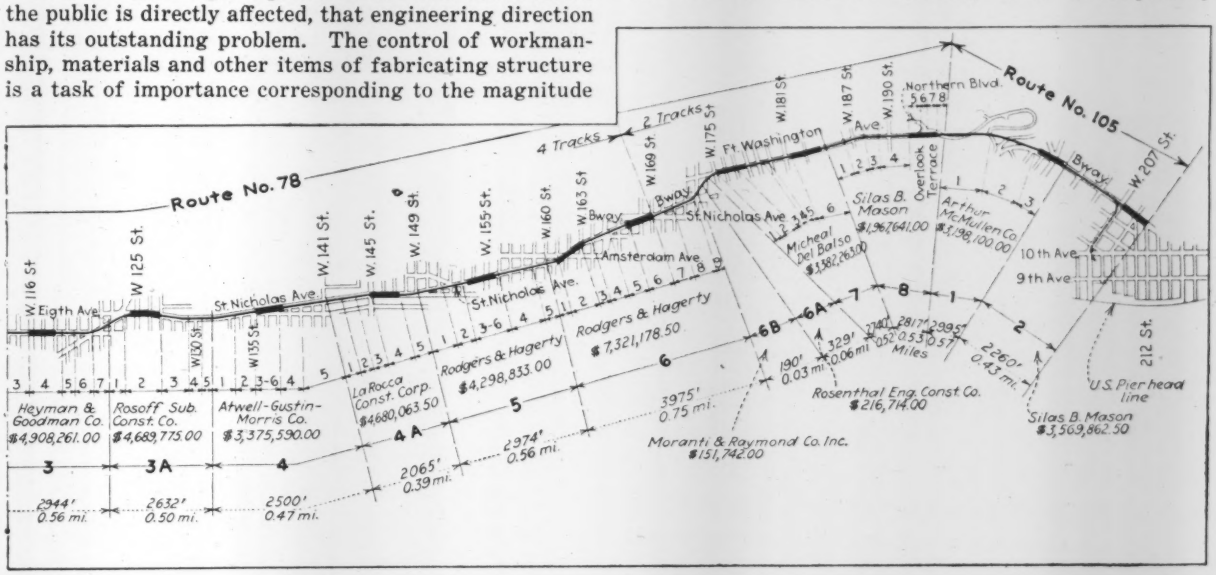
Organization Directing Construction—Construction control of subway work is vested in the engineer staff of the Board of Transportation of the city of New York. More specifically it is in the hands of the Construction Division of the engineer staff; the intercourse, however, is at all times close with the Design Division. A general organization chart of the Board of Transportation is given by Fig. 2. A deputy chief engineer is in general charge of construction and has under him a number of division engineers—at present five, of which three are in charge of line construction. The arrangement is flexible, other divisions can be created as may be necessary. Fig. 3 is the organization chart of a construction division. There is a division office and then a number of sub-divisions each including about four contract sections. Either the number of sub-divisions or the number of contract sections in each can be increased as indicated by the chart.

This is the framework of organization—the engineer personnel is the flesh and integument. This is highly responsible down to and including the section engineers. The men on the sections are assumed capable of handling all the section problems and are held responsible for their handling. So also the sub-division men are held responsible for sub-division problems and the division men for division problems. The theory is to handle each problem where it lies and not carry it up the line of executive authority. It does not always work out, but it is striven for and obtained as far as the men will work together and are capable. Co-operation is held to be the spirit of the organization body. It is invoked not only between the engineers of the division, but between them and the contractors and in all ways throughout the directing personnel. To this end red tape is cut freely and the men are encouraged to negotiate and advise directly across the organization and not go too much up and down the ladder of official authority.

A policy that is stressed is co-operation with the contractors. With the engineers of the Board they are held to be the joint agents of the city for the construction of subways. Therefore in all their tasks they are given every advantage which the interests of the public considered broadly will permit. The theory behind the management of construction is non-interference to the greatest extent practicable with street travel and with the occupations in the buildings along the street. Nevertheless it is considered that there must be recog-

nition of the facts that a great public improvement is being carried out; that, with all present surface and subsurface street structures, an under-street structure virtually the full street width and deeper than the ordinary bordering building foundations is being produced; that construction speed and economy call for power equipment and that this requires room and therefore street opening at the start to dig in and get under the surface, that, in brief, with all due deference to public convenience, there must be abnormal street conditions during subway construction.

It is in regulating the phases of construction wherein the public is directly affected, that engineering direction has its outstanding problem. The control of workmanship, materials and other items of fabricating structure is a task of importance corresponding to the magnitude of the subway operations but it all falls within customary good practices in engineering construction. It is with the plans for maintaining street surfaces, maintaining building services and safeguarding life and property that this review deals.



CONTRACT SECTIONS, CONTRACT PRICES AND CONTRACTORS

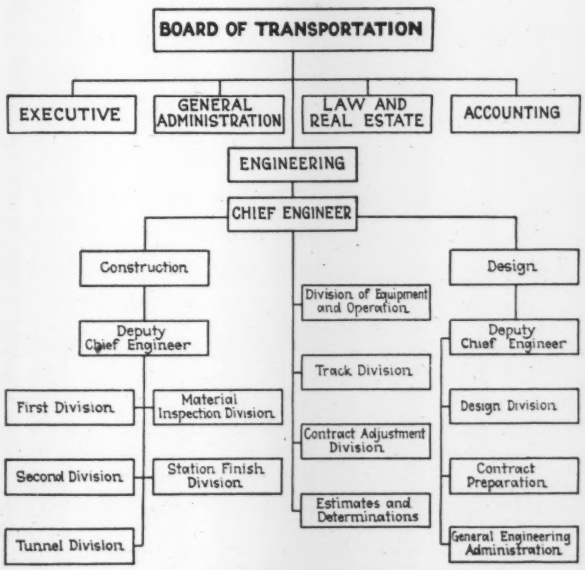


FIG. 2—GENERAL ORGANIZATION CHART NEW YORK BOARD OF TRANSPORTATION

Maintaining Street Service—Surface use of the street for travel is the first consideration. The requirements as stated in the specifications are:

47. In order to minimize interference with traffic and inconvenience to abutting property owners, during the construction of the railroad, on all parts of the work (except parts excavated by tunneling), the streets and sidewalks shall be substantially decked or covered over, and every precaution must be taken to keep traffic free from interruption.

The street supporting system and street decking shall be substantially constructed of ample strength to safely carry the loads to which the surfaces, which it temporarily replaces, are subject. However, the contractor is privileged hereunder to restrict the use of the street decking to trucks and other vehicles weighing, including the load, not in excess of ten (10) tons carried on one axle and to limit the live load upon the decking to three hundred (300) pounds per square foot. In every case, however, where the loads are so restricted or limited by the contractor he shall at his own cost erect and maintain in the streets display signs visible at all times and take such other precautions as may be necessary to caution the public against placing excessive loads upon the street decking. Before the decking and street supporting system are placed, the plans for them shall be submitted to and shall be satisfactory to the engineer. In excavations covered by decking a means of illumination, satisfactory to the engineer, must be provided and maintained at all times, whether work is or is not in progress, so that the supports of the decking may at all times be readily inspected; and as a further means toward this inspection, galleries or walkways must be provided beneath the decking, so that inspection of its supports may readily be made when the excavation reaches such depth as, in the opinion of the engineer, to render such walkways necessary.

49. The street intersections, except where working shafts or ramps are located, shall be kept at all times open for traffic for their full width. Where the decking is temporarily removed from any part of the street the opening shall be protected by suitable fencing and bridging. Generally the fences shall be not less than four (4) feet high and shall have two or three horizontal rails or as may be necessary to provide safety according to the local conditions.

In all cases the contractor shall at all times at his own expense keep all the street crossings on the lines of the sidewalks in a clean and neat condition, bridging gutters and low places where water might collect.

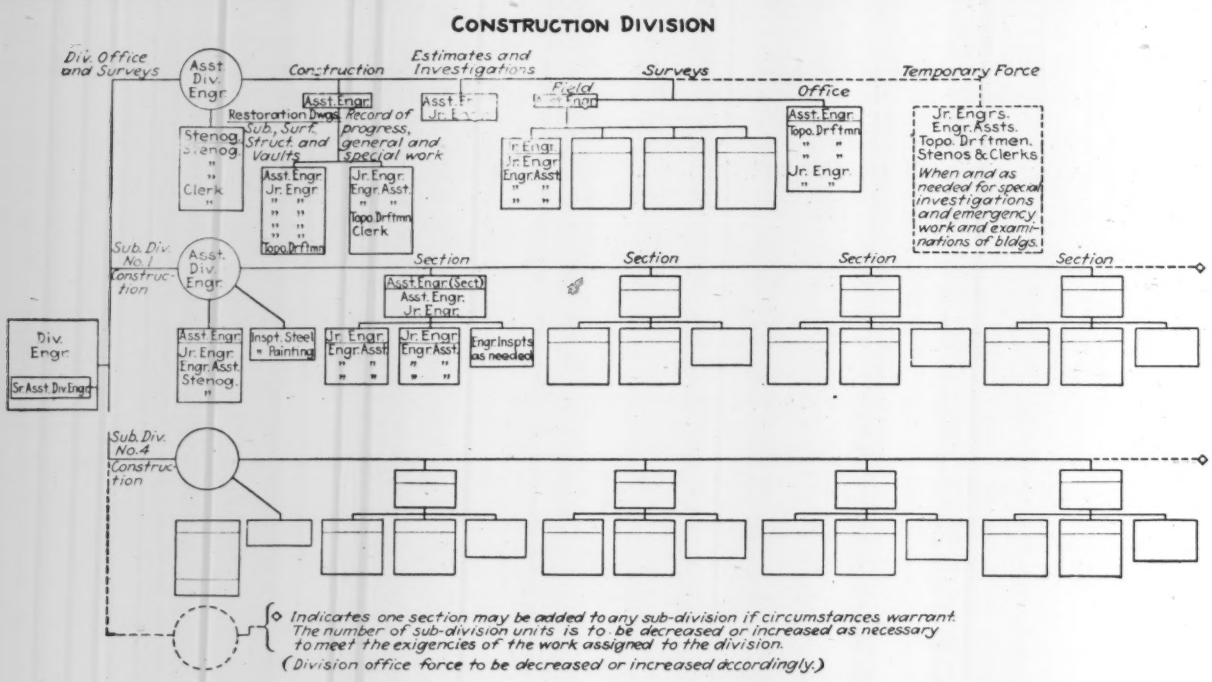

CONSTRUCTION DIVISION
Div. Office and Surveys
Asst. Div. Engr.
Construction
Estimates and Investigations
Surveys
Temporary Force
Office
Asst. Engr.
Stenog.
Clerk
Restoration Dwgs. Sub., Surf. Struct and Vaults
Record of progress, general and special work
Jr. Engr.
Engr. Asst.
Topo. Drftmn.
Jr. Engrs. Engr. Assts. Topo. Drftmen. Stenos & Clerks. When and as needed for special investigations and emergency work and examinations of bldgs.
Sub. Div. No. 1 Construction
Section
Asst. Engr. (Sect.)
Div. Engr.
Sr. Asst. Div. Engr.
Inspt. Steel & Painting
Engr. Inspts. as needed
Sub. Div. No. 4 Construction
Indicates one section may be added to any sub-division if circumstances warrant. The number of sub-division units is to be decreased or increased as necessary to meet the exigencies of the work assigned to the division.
(Division office force to be decreased or increased accordingly.)

FIG. 3—CONSTRUCTION DIVISION ORGANIZATION CHART, BOARD OF TRANSPORTATION

50. The engineer will insist upon the close observance of the above requirements of this subdivision and no departure therefrom will be allowed, except upon the written permission of the engineer.

These requirements are definite. Openings in the street are classed as temporary concessions granted as they are determined by the engineers to be necessary to the work. So also is the use of the streets for storage a temporary concession. The location and number of street shafts or ramps, of office and other buildings, of construction plant units depend likewise on the engineers' permission. Specifically, hindrance by construction operations to free surface use of the streets is not contemplated except as a temporary privilege determined by the engineers' judgment.

Subsurface street structures, as water and gas mains, sewers and conduits for electric cables are required to be maintained in service. The general clauses of the specifications governing this feature are as follows:

58. The contractor shall at all times, by suitable bridging or other supports, maintain and support in an entirely safe condition for the usual service and to the reasonable satisfaction of the owners, all surface, subsurface and overhead structures and all their appurtenances encountered or affected during the prosecution of his work; if the maintenance of such usual service makes it necessary, the contractor shall temporarily remove and relay or reconstruct any such surface, subsurface or overhead structure and shall restore the same or reconstruct the same in a new location prior to the completion of this contract. Also, in order that access may be had in emergencies to gates or valves on water, gas or other mains and to electric and other manholes, where such gates or valves and manholes are decked over, trap doors of a suitable size shall be provided in the decking. Whenever an electric manhole has been removed it shall be replaced by a temporary manhole,

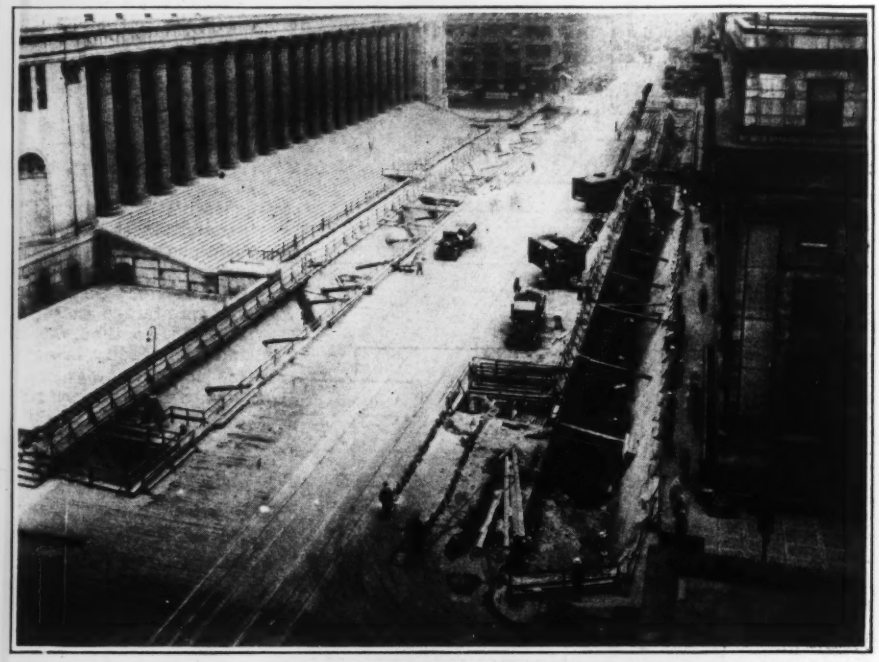


FIG. 4—EIGHTH AVE. BETWEEN PENNSYLVANIA STATION AND GENERAL POST OFFICE
On Post Office side decking is completed to car tracks. On opposite (right hand) side see pavement being cut out, cranes and trucks for preliminary excavation and in distance patch of pavement removed and deck joists in place.

FIG. 5—EIGHTH AVE. SOUTH FROM 35TH ST.
Side trenches being opened in sidewalk area to get under street and excavate for decking. On left in third block is the Pennsylvania R.R. station with the general post office directly across-street.

which shall be so constructed as to reasonably provide the usual facilities, and the cables shall be supported by temporary racks. Wherever possible and as determined by the engineer, reasonable, the ducts shall be supported and maintained but whenever it becomes necessary to remove the ducts from the cables the cables shall be protected by a satisfactory boxing. Insulating coverings consisting of manure, hair felt or asbestos wrappings and boxings or other approved material and construction shall be provided and installed by the contractor for the protection of exposed water mains, and house service pipes as may be necessary to maintain the efficiency of the service within such pipes and to prevent freezing in water mains and house service pipes; to maintain the efficiency of such insulating material or construction it shall be protected by waterproofed wrappings or boxings or both, as necessary. All surface, subsurface and overhead structures and all their appurtenances and all surfaces of whatever character along the line of the work shall be protected from injury,

FIG. 6—EIGHTH AVE. SOUTH FROM 41ST ST.
Observe side trenches, traffic, parked vehicles, character of buildings and in third block telphers for handling excavation.

and the contractor shall fully restore such surface, subsurface and overhead structures and all their appurtenances and all such surfaces to, and shall leave them in, as useful, safe, durable and good a condition as existed before construction was begun.

These requirements apply only to maintenance; where

FIG. 7—TELPHERS USED BY ONE CONTRACTOR FOR LOADING TRUCKS
These machines on towers on carriages move along as excavation progresses. They stand virtually within the sidewalk area.

the conduit, because of physical interference with the subway structure, has to be reconstructed it is held a part of the new structures and is provided for in the engineering plans and specifications.

Maintaining Buildings—Where excavation of subway may be carried to depths that may cause disturbance to the soil supporting adjacent buildings they are required to be underpinned as specifically named.

66. By underpinning is meant such method of construction as will transmit the foundation load directly through the underpinning structure to such lower level as is necessary to secure the buildings and which will relieve the adjacent ground and railroad structure from undue lateral pressures. The underpinning shall be designed to furnish a safe and permanent support for each independent building. To accomplish this result, the contractor shall use such methods of underpinning, pneumatic or otherwise, as special conditions may require and the engineer shall approve.

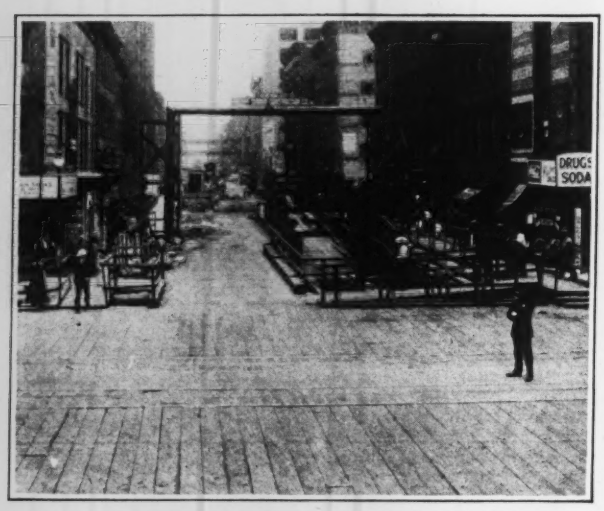


FIG. 8—EIGHTH AVE. LOOKING WEST ON 36TH ST.
Street decking in place; ramp emerging into side street under construction; overhead bypass for gas main.

Besides keeping structures intact it is required that the building services shall be maintained; entrances must be kept accessible and all the conveniences of doing business kept as undisturbed as practicable.

Guarding Against Hazards—Potential hazard to the public in subway construction is naturally large. Openings in the street, handling materials and operating machinery in congested thoroughfares and blasting operations have great possibilities of danger unless well safeguarded. In the agreement the contractor takes the responsibility for safeguarding the public but general requirements are laid down by the engineers. Some of these are indicated in the quotations previously given. Others in respect to excavation and handling materials, embody the usual safeguards in respect to sheeting and bracing trenches, handling explosives and conducting blasting. City ordinances govern many of these operations and are too many to cite but all are required to be observed by the contractor. In brief the purpose is to reduce hazard to the public by every reasonable precaution. Causes of annoyance are eliminated as far as practicable:

Decking of the streets, paving, or other surface work affecting, or affected by, street traffic, shall be prosecuted during such hours as will reduce such interference to a minimum. Night work shall be conducted, in accordance with the directions of the engineer, so that annoyance to occupants of abutting property shall be reduced to a minimum, and the engineer may, if in his judgment conditions so require, direct that night work be omitted.

The contractor shall provide working machinery designed to operate with the least possible noise; hoists and compressor plants shall be electrically operated unless otherwise permitted and machinery operated by gearings shall be provided with a type of such gearings designed to reduce noise to a minimum.

Conclusion—To epitomize, in conducting the new subway work the service, safety and convenience of the public are recognized fully and are planned to be maintained in every practicable way. As far as practicable general requirements are specified but in a large way it has to be left to the judgment of the engineers how far maintenance and protection shall go and not hamper construction beyond any benefits to be gained.

Organization—The Board of Transportation, which is constructing this subway system, consists of John H. Delaney, chairman, and D. L. Ryan and William De Ford, commissioners. The work is being designed and supervised by its engineering department, of which Robert Ridgway is chief engineer. Col. J. R. Slattery is deputy chief engineer in charge of construction, and Sverre Dahm is deputy chief engineer in charge of design. J. O. Shipman is engineer of the First Division, John H. Myers of the Second Division, J. B. Snow of the Tunnel Division, H. N. Latey of equipment and operation, R. H. Jacobs of the Track Division, J. T. Kane of the Station Finish Division and A. I. Raisman of the Designs Division.

Triangulation Work in the Cascades

Triangulation work in the Cascade Mountains which has been started by a party from the U. S. Coast and Geodetic Survey, will be performed by simultaneous use of five theodolites. The observations required in connection with triangulation work are particularly difficult to make in the Cascades during the summer months because of the smoke from forest fires and the breaking up of glaciers. Last year a party encountered such a pall of smoke that observers were unable to see the electric signal lights. No progress could be made in observing until after the snows and rain had begun in September, but then there arose the danger of being snowed in, as well as the hazardous task of traversing glaciers. In the summer of 1925 only about two weeks of clear weather were available for making observations. All of the trouble which the 1925 party encountered, it is hoped, will this year be avoided. The only method by which the dozen or more stations can be occupied as quickly as is contemplated is to have each of a number of mountain peaks occupied by a separate party with its own theodolite. There are five particularly difficult mountain peaks in the center of the range close to the international boundary between Canada and the United States. An observer went to each peak on June 29, well equipped not only to make his own observations but to exhibit signal lamps for other parties. When the observations are made on those peaks observers will occupy lower stations but the signal men will remain to flag instrument men occupying the lower stations.

Civil Engineers Meeting Centers on Western Problems

Summer Meeting of Am. Soc. C. E. at Seattle Includes Eight Technical Division Sessions—Main Emphasis of General Session on Logging and Forestry as Practiced in Northwest

(Engineering News-Record Staff Report)

ABOUT 225 members registered for the summer meeting of the American Society of Civil Engineers, which was held in Seattle, Wash., July 14-16. On the first day both morning and afternoon sessions were devoted to a series of papers by experts from the Northwest lumbering country on various phases of logging, sawmill practice and reforestation. On the second day in both morning and afternoon there were simultaneous sessions of four technical divisions, making eight in all; necessarily there could not be very great attendance at any one.

Some distinction was added to the opening meeting by the presence of Governor Hartley, of Washington, and Mrs. Bertha K. Landes, the recently installed mayor of Seattle. Excursions were run on Friday to a logging operation at Snoqualmie Falls, and to the power dams at Lake Cushman and on the Baker River. On Saturday, as an extra trip, the Great Northern Ry. took some of the members to the new 8-mile Cascade tunnel under construction.

Lumbering Symposium

Lumbering—Six papers within the general classification of lumbering stressed the importance to the industry of services that the engineer can render in speeding up production and reducing costs. The logging railroad was cited as the most necessary and the most expensive single item in a logging operation; motor trucks and log flumes also received attention. In the discussion of woods operations it was noted that the ground yarding plan, universally used ten years ago, has now been almost entirely replaced by the high lead system. In building inclined railroads where the grade is steep enough to warrant counterbalancing, engineering principles are being applied effectively in working out grades and control equipment most advantageous for the loads and topography involved. One speaker believed that the airplane could be used in the preparation of mosaics that would be of great value in laying out the logging operation as a whole, but did not regard it as suited to developing topography in rough timbered country.

Forestry—Reforestation, together with the protection and the proper taxation of timber stands, received the most attention in the first day's discussions. Fire constitutes the greatest menace to timber stands but windstorms, fungus diseases and insect pests are also to be considered. More research is needed on the utilization of material wasted in slashings; one pulp and paper company of the Northwest has been able to use most of this waste by a process whereby digesters separate the useful pulp from the trash.

Revision of the Washington state law on taxation of timber and cut-over lands is proposed in a constitutional amendment to be voted on this fall. The present plan, by continuing an annual tax on timber until cut, tends to hasten cutting as a means of reducing taxes on timber holdings, whereas the proposed plan, by postponing the major tax until the timber is cut, will tend to conserve the timber for future use and will also encourage the reforestation of cut-over lands.

The more progressive lumbering companies, one speaker pointed out, are coming into closer accord with public interests and government activities in reforestation. With more educational campaigning, common ground may soon be reached. Under favorable conditions cut-over lands can be made to produce a second crop in about 50 years, it was said. Indicating the importance of reforestation: in Washington the lumber industry provides 65 per cent of the industrial payroll, 80 per cent of the boat tonnage on Puget Sound and 60 per cent of the transcontinental freight on railroads leaving the Puget Sound territory. As a whole, the keynote of the first day's discussion was the necessity of more engineering thought and practice in the lumbering industry.

Logging Railroads—Walter J. Ryan, civil engineer of the Weyerhaeuser Timber Co. of Tacoma, outlined the gradual development of a well established engineering art in location and construction of logging railroads. Emphasizing the essential differences between such roads and common-carrier railroads, Mr. Ryan gave the chief location and construction data. Main lines are laid out with grades as high as 4 per cent and curves as sharp as 24 deg.; the logging spurs with grades up to 6 per cent and curves up to 40 deg. Cable inclines are used where necessary. Grading has been done largely by hand, but is now done by drag scraper, small power shovel, or similar type of machine. Trestles and bridges are of various construction, generally of timber, sometimes of a combined beam and suspension type, composed of groups of longitudinal timbers above and below a tie deck, the whole bolted and laced together with bolts and cables; built on falsework, such bridges have been used on spans of 100 ft. Gravel ballast is widely used, especially on the western slope of the Cascades. Rail (usually 60-lb., and mainly relay rail) is laid at standard gage, with rail braces or tie plates or both on curves, and with some attempt to anchor the track, creeping being a serious difficulty. Rolling stock consists of separate trucks equipped with log bunks, standard cars, and trucks connected by a center sill carrying the brake equipment. Locomotives are geared, Mikado or Mallet of rather light weight, preferably oil burning. Present practice is remarkably efficient, but there is a large field for the development of location economics.

Logging Flumes—In a comprehensive paper by U. B. Hough, consulting engineer, Spokane, the main features of logging flumes were discussed. The flumes, triangular in section, are built to carry logs up to 3 ft. in diameter, by gravity aided by a small flow of water, and are used for distances up to ten miles. They have to be built along the ground, for the logs are loaded into them all along the line, and have to be kept at a grade sufficient to insure travel. This grade varies up to as high as 40 per cent, but where grades are broken great care has to be taken with the vertical curving. Equal care is needed with the horizontal curves to prevent climbing. The water supply need not be great, because it is in use only when the logs are being run, but in many cases dams have to be built for storage and in some places bear-trap gates are needed to permit the logs to be run out of the same pond that supplies the water. The logs in running tend to pile up the water ahead of them, so that only a small flow is required, but it is

enough to prevent much wear on the slide timbers. One such flume described cost around $9,000 per mile, and removed 60 million feet of logs, at a total cost of construction and upkeep and attendance of $2.27 per thousand feet.

Reforestation—E. T. Allen, forester of the Western Forestry & Conservation Association of Portland, under the title "Economic Aspects of Reforestation," contrasted the viewpoints of the forester, the lumberman or timberland owner, and the public. The forester's ideals, he declared, can at this time hardly be brought into agreement with the economic possibilities. However, he indicated clearly that Puget Sound lumbermen are both by choice and necessity adopting the policy of developing new stands on their cut-over lands, although the lumberman "does not know whether the harvest will pay, or whether he, another, or the public will reap it."

Highway Division

O. L. Waller and H. E. Phelps (State College of Washington) reported some tests they have been conducting looking into the destructive effect on automobile tire tread rubber caused by different types of road surfaces. Macadam road surfacing and highway bridge economics were dealt with in other papers.

Tire Wear and Road Surface — Tentative conclusions drawn by Waller and Phelps from their studies to date are:

(1) Tire wear increases with the speed. Sufficient data are not available to indicate the rate of increase.

(2) Tire wear increases with the temperature. Road tests indicate this relationship, but are not consistent and yield no information as to the rate of increase. Laboratory tests are likewise not conclusive, but indicate a moderate rate of increase in tire wear with increase of temperature. High temperatures are very destructive to tires.

(3) The wear of rear tires is greater than that of front tires, the relative wear of rear tires being 200 per cent on smooth pavements and as little as 118 per cent on gravel surfaces, probably averaging 150 per cent of the wear on front tires.

(4) Tire wear per ton of car is probably constant for any given road surface, when size of tire, load and inflation pressure are determined by a single standard.

(5) A few records of bus companies show actual tire mileage life on different road surfaces in approximate agreement with tire wear tests on similar surfaces.

(6) Relative tire wear index numbers, based upon average concrete pavement as 1.0, are approximately 2.0 for good gravel and macadam, 4.0 to 5.0 for average western macadam or uncrushed chert gravels, and may be as high as 10 or 11 for unusually unfavorable surfaces. Based upon tire wear alone average size cord tires should show a life of 20,000 to 24,000 miles upon pavements, 10,000 to 12,000 miles on good gravel or macadam, and as little as 2,000 to 4,000 miles upon unfavorable surfaces. The corresponding costs per vehicle mile are about 0.5 cents for pavements, 1.0 cents for average gravel or best macadam, 2.3 cents for average macadam, and may be as much as 5 cents per vehicle mile upon road surfaces of loose sharp-edged stones.

Stone and Gravel Surfaces—J. W. Hoover, state highway engineer of Washington, in "Modern Crushed Stone and Crushed Gravel Surfacing," emphasized the relation between traffic density and type of surfacing, but took sharp issue with those who would fix a definite traffic density as the point of economic change from a surfaced to a paved road, especially figures of 400 to 500 cars or tons per day. He said "I doubt if many paved roads are carrying less than 1,000 cars per day and certainly thousands of miles of gravel roads are carrying more than 1,500 cars per day." For light traffic he suggested a surface 12 ft. wide and 6 in. thick; for traffic nearly heavy enough to justify paving, a cross-section approaching that of pavement design, not less than 18 ft. of surfacing with edge thickness of 9 to 10 in. and center thickness of 7 to 8 in. The thickness, however, depends on climate as well as traffic; light surfacing holds up well in the arid regions of Washington with 6 to 10 in. annual rainfall, while in the heavy-rain region (over 100 in. per year) the surfacing must be heavy.

In discussion Roy A. Klein, state highway engineer of Oregon, emphasized the dominant position of the crushed stone and gravel road for some time to come in the rural highway scheme of the country. Mr. Klein noted that abrasive tests normally conducted on such road materials when dry are not trustworthy guides, in view of tests by his department showing that wet materials suffer four times the abrasion of the same materials when dry. He stated also that his experience indicates that clay-bound surfacing is not ready for oil treatment until it has gone through a winter season.

Highway Bridge Economics—C. B. McCullough, bridge engineer, State Highway Department of Oregon, presented an analysis and series of charts indicating the relative economy of various types of highway bridge. His analysis took into consideration the several factors of capital investment, maintenance, replacement, insurance and other operating factors and derived factors.

Power Division

In the power division a moving picture of the Stevenson Creek test dam, now completed, was viewed with particular interest, indicated by the numerous questions asked of H. W. Dennis, construction engineer, Southern California Edison Co., whose explanation accompanied the picture. The technical papers of the session dealt with various power plants of the Northwest and the general power situation of that region.

Northwest Power Development—Reviewing the present power situation in Washington, where a total of about 750,000 hp. has now been developed, Prof. C. W. Harris (University of Washington) stressed the importance of the small hydro development and, including such developments, estimated that there would ultimately be a total installed capacity in the state of 20,000,000 hp. There are notable large power sites in Washington, of which two exceed 1,000,000 hp. and six exceed 500,000 hp.

Lake Cushman Development—Details of the design and construction of the Lake Cushman hydro development (city of Tacoma) were presented by J. L. Stannard, chief engineer of the project. The transmission line from this plant has a 6,240-ft. span across an arm of Puget Sound, on which three 1¼-in. steel conductors are used, each designed to withstand a pull of 180,000 lb. Features of the span are the porcelain strain insulators at the anchorages and the use of two auxiliary lines on each cable near the ends to decrease vibration. The sag in the span is about 400 ft.

B. E. Torpen, superintendent of design and construction on the Cushman project, outlined tests made on models of concrete arch dams to check theories now in use. The tests showed the cylinder and the Cain formulas to be satisfactory for thin dams, but in thick arches, according to tests on models 7 ft. high and 7 ft. wide and of thicknesses varying from 18 to 24 in., results do not check with the Cain formula by several hundred per cent. In these tests 500-lb. concrete aged 14 days was used, so that the tests could be carried to destruction. Using the results of these tests as a basis for calculation, Mr. Torpen predicted that the Stevenson Creek test dam would not fail even when tested at its full height of 100 ft., but would have a factor of safety of 2.

Chelan Development—The Chelan hydro development, described briefly by Victor H. Greisser, chief engineer Washington Water Power Co., Spokane, has a 950-sq. mile water shed and an average low water discharge of about 2,000 sec.-ft. A static head of 415 ft. is being developed by a low dam and a 12,000-ft. length of tunnel 14-ft. in diameter.

Two Plants Compared—W. D. Shannon, general superintendent, Stone & Webster Inc., Seattle, made a comparison of the features of the Lake Cushman and Baker River projects, which have many points of similarity. Both are compact developments and the dams are of nearly the same size. The Cushman project has a constant angle arch dam, while the Baker River dam is of the semi-gravity type, thus affording an opportunity for comparison of cost in formwork and other construction problems. With the greater runoff at Baker River the annual production is estimated to be 236 million kilowatt hours as against 105 million kilowatt hours at Lake Cushman. The Cushman plant has been machined for more than three times the continuous flow of the stream, Mr. Shannon said, but its location with-

relation to Tacoma's La Grande plant will permit of effective combination.

More Skagit Power—Further development of three power sites on the Skagit by the city of Seattle was reviewed by Joseph Jacobs, consulting engineer, Seattle. The program has been worked out to meet the needs of a population of 950,000 (in 1950). The ultimate development planned by the city on this stream is 475,000 to 650,000 hp. according to the alternative selected.

Structural Division

With about 50 present, the structural division dealt with a program of six papers, most of them of considerable weight. The remarkable Coolidge Dam design was described, unfortunately without drawings and without discussion. Structural welding, earthquake resistance of substructures, foundation research, and bridge and arch questions were also dealt with.

Coolidge Dam—Major C. R. Olberg, assistant chief engineer of the Indian Irrigation Service, outlined the conditions governing the San Carlos irrigation project in Arizona and the special reasons that led to a search for a highly economical type of dam for the 250-ft. storage structure. The multiple-dome design, developed through this search, has a general similarity to a multiple-arch structure, but the individual spans are long (buttresses 180 ft. c. to c.) and the arches are of variable spans horizontally and have a sharply curved profile vertically. The thickness of the arches at the crown varies from 4 ft. at the crest to 21 ft. at the river bed; the buttresses are 60 ft. thick at the base of the downstream side and 110 ft. thick at the heel, where they merge into the dome. In general, stresses in the concrete of the structure were kept below 600 lb. per square inch, including temperature and rib shortening.

Foundation Research—Charles R. Gow, of Boston, reviewed the course of research in connection with foundation problems in recent times, and devoted particularly close attention to the researches of Dr. Charles Terzaghi, whose work he gave high commendation. His paper centered in a plea to engineering schools and other students to join in carrying forward research studies along the lines Terzaghi has marked out.

Harrison P. Eddy (Boston) strongly endorsed the call for more research in foundations and earth in general, and emphasized our ignorance of the properties of soil and our adherence to individual opinion rather than test values. D. E. Moran (New York) expressed the belief that the Terzaghi researches show the way out of present insufficient understanding of soil physics, but also pointed to the need of studying the mechanics of stress actions in soils, particularly in view of the complex distribution of stress through masses of aggregates.

Structural Welding—Prof. Frank P. McKibben, of Union College, Schenectady, reviewed the present status of structural welding, reciting recent practical applications done both with electric and with gas welding. He emphasized the importance of the advance made by the recent invention of hydrogen-gas processes of arc welding, which by shielding the fused metal from oxidation enable highly ductile welds to be obtained. Forms of design are bound to change when welding is made the basis of design instead of riveting, he predicted, possibly with partial abandonment of angles in both tension and compression members, as being not particularly efficient but used mainly because of their convenience in making riveted connections. Prof. McKibben called for fuller test data to be obtained as soon as possible, as the basis for satisfactory design, "otherwise the prevalent tendency to base conclusions on a few tests may lead to erroneous and unsafe designs." For electric welding, he gave the following average strength data, based on present information: Ultimate tensile strength of welded joints, 40,000 lb. per square inch of weld section. Efficiency of butt joints in tension, 60 to 100 per cent, lap joints, 50 to 100 per cent. Ultimate shearing strength, 36,000 lb. per square inch of shearing section of weld.

W. L. Warner (General Electric Co.) and J. H. Edwards (American Bridge Co.) presented the respective optimistic and conservative views of the subject. Mr. Edwards sounded a warning against going ahead too fast in structural welding in the present state of the art and emphasized the importance of research work, such as that recently initiated by the American Welding Society through a committee on structural welding.

Earthquakes—What is known today of the relation between earthquakes and engineering substructures—foundations, pipes, tunnels, and the like—was outlined in a paper by Henry D. Dewell, San Francisco. The paper first outlined the nature and quantitative aspects of earthquake action, and then considered the inherent earthquake-resisting characteristics and the performance history of different types of structures: Dams, pipe lines, sewers, tunnels, bridge piers, and foundations. A decidedly favorable prognosis was given for dams, largely on the basis of San Francisco (1906) experience. Discussions by Walter E. Spear (New York) and Dr. Baily Willis (Berkeley) raised additional questions and stressed the inadequacy of knowledge on the subject. Dr. Willis, agreeing with the author in general, took exception to his claim that deep pile foundations to solid ground are much safer against earthquakes than spread footings, in view of the likelihood of sway in the loose stratum causing superstructure movements. He also was less optimistic as to the security of earth dams.

Timber Bridges—C. E. Andrew (bridge engineer, Washington Highway Department) reviewed recent timber bridge practice on the Pacific Coast. The economic considerations bearing on the choice of timber received special attention.

Integral Arch Action—A remarkable series of facts developed in study of distribution of stresses in concrete and bridges was brought out by Prof. George E. Beggs (Princeton University). He has found by "deformeter" studies of rib arch bridges that the whole structure acts jointly as an arch, the spandrel columns and floor taking a considerable amount or arch thrust. This action may go so far that concentrated load at certain points of the span produces a *tensile* stress in the arch rib. The results have already found practical application both here and in Europe, and they foreshadow extensive revision of methods of arch analysis and design. In a specific case the maximum moment in the rib was reduced as much as one-ninth by co-operation of the floor in the arch action.

Construction Division

"Earthwork by the Hydraulic Method," by R. E. Miller, general manager and vice-president of the Puget Sound Bridge & Dredging Co., was the first paper read in the construction division, where about 60 were present. It gave the results of practical research in determining the relative cost and merits of various materials to be dredged into fills.

"Problems in Concrete Dam Construction on the Pacific Coast," by Arthur S. Bent, Bent Bros., Los Angeles, pointed out fundamentals that must be considered in advance in order to make a success of dam construction. The contractor should stand at the untouched dam site and visualize the steps of the work from beginning to end. Some of the factors he must consider are character of the engineers in charge, remoteness of the site, probability of flood dangers, feasible methods of stream diversion, space for spoil, and, finally, selection of plant and methods. The importance of a suitably equipped camp can hardly be overrated, nor can the selection of a superintendent, whose resourcefulness should be that of a good military commander. The capacity of the aggregate plant should be 50 per cent beyond the estimated needs, and this may well be doubled on a rush job. Loss and waste are likely with the lowered morale at the time of demolition if not given special attention.

Arthur P. Davis, chief engineer, East Bay Municipal Utilities District, Oakland, Calif., reviewed the program and progress to date on the Mokelumne water supply

project, noting particularly the methods and the changes made during the welding of 63- and 65-in. pipe for the 40-mile conduit. While the electric welding in the shop is successful, riveted field joints have been substituted for the oxyacetylene welding and consideration is now being given to the possibility of again changing the field work, this time to tapered joints made tight by electric welding in the field.

Irrigation Division

One of the most interesting subjects of the entire meeting, land reclamation economics, was dealt with by the irrigation division before an audience of only 35. David C. Henny (Portland) read a paper on "Some Phases of Irrigation Finance." Thomas H. Means (San Francisco) and M. C. Hinderlider (Denver) brought forward some sharply diverging views in discussion, the latter standing strongly for the justifiability and wisdom of federal financing of all worthy projects whose cost is beyond the ability of a state or corporation to finance. We hope to give fuller notice of this paper and its discussion in a later issue.

R. K. Tiffany (State Supervisor of Hydraulics, Olympia, Wash.) explained in a paper the progress and policies of state reclamation in Washington since 1919, when a law provided for a state-wide levy of one-mill on all taxable property, the proceeds to be devoted to the purchase of bonds of organized irrigation districts and construction of new works the bond for which might later be sold in the general market. Few new projects were started, but several old ones were aided by the state, with no very great success, since of a total investment of $2,200,000 from $777,000 to $1,093,000 will probably prove a total loss. Too much "lame duck" aid was probably the cause of the trouble but nevertheless the scheme is now in bad odor and a legislative committee is to report on a future policy next October. Mr. Tiffany concluded his paper with some thoughts on the proper policy for state and nation to pursue in reclamation work.

Sanitary Engineering Division

Ocean Disposal—At no time were there more than 25 in attendance at the Sanitary Engineering division, but there was active discussion of the three papers, centering mostly on the desirability of ocean disposal of sewage. The question was first brought up by W. F. Allison (University of Washington), who in discussion of "Stream Pollution in the Pacific Northwest," commented unfavorably on the proposal now alive in Seattle to direct into the ocean beyond the ridge to the west the sewage now discharged to the east of the city into Lake Washington. A. H. Dimock (Seattle) contended that such disposal is safe inasmuch as the tidal currents at the outfall all go away from the shore, but Prof. Allison maintained that with the extensive use made by bathers and residents on these shores offense would be bound to result. He urged a speedy determination by proper bodies of a limit of pollution allowable in the ocean waters of this Northwest coast, to prevent a future pollution such as, he said, is now so much of a problem in the older Eastern communities. His paper also referred to the pollution by the city of Spokane of the Spokane River and the Columbia River (into which it empties) and suggested that typhoid in the lower cities might result from a continuation of the practice. A. D. Butler, city engineer of Spokane, said that the city tests the waters of the Spokane and the Columbia ten times a year, and intimated that the danger of lower pollution does not now exist.

Los Angeles Sewerage—Two papers, by W. T. Knowlton (sanitary engineer of the city) and by A. K. Warren (chief engineer of the county sanitation districts), described the work of the Los Angeles sanitation districts. Both were categorical descriptions of the sewerage systems which the phenomenal growth of that region has imposed in the past few years. Both the city and the county depend upon outfall sewers into the ocean. The city uses screens to remove solids and the same method is proposed by the districts. Mr. Knowlton said that outside of a mile-long shore that the city owns directly at the outfall the pollution as revealed by *B. Coli* count is well within the permissible limit, but Mr. Warren noted that the county plan for an outfall is being held up by the state board of health until some more satisfactory solution of the possible pollution of the nearby shore can be reached. Meanwhile, however, construction of the interior trunks is going ahead. Mr. Warren's paper had an excellent description of the methods used by the engineers to educate the electorate as to the necessity for the sewerage plan just prior to the bond election authorizing the project.

Other Divisions

Only about 20 persons attended the meeting of the City Planning Division, where the discussions were on the regrade operations undertaken a number of years ago in Pittsburgh and in Seattle, with one paper on the city planning operations of the new lumber city of Longview, Wash. About 25 were in the session of the Waterways Division, where the port and waterways of Seattle were described in two papers.

Investigate Concrete Exposed to Alkali

Results of an investigation undertaken by Salisbury, Bradshaw & Taylor, consulting engineers, Los Angeles, to determine the effect of alkali on concrete in alkali soils in Southern California have recently been published by the California Portland Cement Co., Los Angeles. The report states that, with one or two exceptions, the investigation disclosed no one who had actually seen and was able to point out a specific case of injury to concrete due to alkali. In cases where injury was observed, it was markedly evident that the concrete was of poor quality to begin with. The following summary of results and conclusions is taken from the report:

(1) Concrete can be made without the use of extraneous substances, which will be imune to injury due to exposure to alkali.

(2) Concrete which had deteriorated, due to alkali exposure, was found to be of inferior quality.

(3) It is safe to use high quality concrete in the worst alkali if the concrete is covered with earth in such a way that not any of its surface is exposed to the air.

(4) Concrete was found in dry alkali soil that showed no evidence of alkali action regardless of the quality of the concrete. So, if the nature of the works did not require dense, strong concrete, a leaner mixture could be specified for dry soil than should be required in wet alkali ground.

(5) Since sewer pipes and land drainage tile ordinarily have part of their interior surfaces exposed to evaporation, the concrete should be of first-class quality

Boiler Steel Embrittled by Caustic Soda

BRITTLENESS and cracking which developed in steam boilers supplied with certain types of well water, treated and untreated, have been studied at the University of Illinois at various times during the last ten years. Some early findings of this study were published in Bulletin 94 of the University Engineering Experiment Station, "The Embrittling Action of Sodium Hydroxide on Soft Steel," 1917. Fuller exploration of such embrittlement has just been reported upon by Prof. S. W. Parr, professor of applied chemistry at the university, and F. G. Straub, special research assistant, in a paper presented before the American Society for Testing Materials last month.

The investigators found that when soft steel is stressed beyond its yield-point and is in contact with strong caustic soda solution, the metal is attacked by intercrystalline corrosion; it becomes brittle, and finally cracks and breaks. *Both factors* must be present; the action does not occur at stresses below the yield point or at low concentration of the alkali. The presence of strengthening alloy material in the steel (up to 3½ per cent nickel, nickel and molybdenum, manganese ranging from 0.01 per cent to 0.76 per cent) had no effect on the action, except in so far as the yield-point strength of the steel was raised by the addition. Phosphorus and sulphur had no noticeable effect in the ordinary ranges, but a high-phosphorus high-sulphur steel (percentages of 0.215 and 0.126 per cent) showed marked acceleration of the rate of embrittlement. Cold working of the metal had no distinct effect.

A test apparatus in which strips of the steel to be tested were maintained under tensile stress within a container for the solution to be tried was the principal source of test data. Individual tests were continued up to a month or more, if fracture did not occur earlier. With this apparatus it was found that the NaOH solution must have a concentration of about 35 per cent by weight (350 g. per liter), and at the same time the stress in the metal must be above the yield-point, to produce rupture in less than a month. Neither strip stressed to 33,000 lb. per sq.in. in a 400-g. solution, nor a strip stressed to 47,000 in a 200-g solution broke (in a 16-day test). Sodium carbonate and sodium sulphate did not bring about rupture, even at stresses approximating 50,000 lb. per sq.in. and in 500-g. concentration. When these salts were present together with an injurious amount of sodium hydroxide, they tended to prevent embrittlement. When the ratio of either sodium carbonate or sodium sulphate to the sodium hydroxide was above 2, rupture did not occur even though the NaOH concentration was above 400 g.

Boiler troubles in practice nearly always developed between the plates at a seam, or in the rivets. Often the rivets became brittle enough for their heads to fly off even before any effect on the plates was noted. Much lower alkali concentrations than 35 per cent were present in boilers that were destroyed by embrittlement, but it is believed that the boiler water penetrating between the laps of the plate at the seams became more highly concentrated in this confined space than the water in the boiler. The embrittled metal becomes covered with a shiny blue-black coating of magnetic oxide. Measurements of electric potential on such a piece of material immersed in 10-normal NaOH solution showed a 1.0 volt for clean metal and only 0.25 volt for the oxide-coated metal; when the coated surface was ground off, the full potential was restored. It is believed that where metal acquires such an oxide coating in the boiler the coating cracks under the mechanical stress in the metal and thus gives the alkali water access to the clean metal below, causing the corroding action to continue into the body of the steel.

Such embrittled metal in all cases showed intergranular cracking under the microscope, whereas other forms of crack, even those resulting from ordinary electrolytic corrosion were typically different, being random or cross-granular.

At the University of Illinois three boiler drums had to be replaced in 1916 after only five years' service, because of embrittlement. Since that time the boiler water in the plant has regularly been treated with lime, agitated and settled, and then dosed with enough sulphuric acid to neutralize about 70 per cent of its alkalinity. This plant is supplied with well water containing from 3 to 22 grains of sodium carbonate per gallon. By the water treatment just described, the sulphate-carbonate ratio of the feed water is maintained at 2. A thorough inspection of the boilers after ten years' operation, last February, showed them to be in perfect condition.

New Refuse Salvage and Disposal Plant for Birmingham, England

IN continuation of its policy of abandoning "refuse tips," the city of Birmingham, England, opened a second new refuse salvage and destructor plant on June 15. The plant, known as the Tyseley works, will serve an area of 87,000 acres with over 46,000 houses and some 210,000 population. The annual amount of refuse produced in this district is 51,500 short tons, says the London *Surveyor* of June 18. Collections will be made by 5-ton electric vehicles.

The mixed refuse is dumped from the wagons into one of two 16.8-short-ton hoppers, from which it passes to one of two rotary screens of ¾-in. mesh. These remove some 40 per cent of "fine dust," which is transported by an "aerial ropeway" to a dumping area. A magnetic separator at each screen removes cans and other magnetic material from the tailings before the latter go to salvage sorting belts. What is left of the tailings is lifted by a "continuous plate elevator specially designed for household refuse" and discharged into one of two 11.2-short-ton hoppers, one above each of the two Heenan & Fraude destructor units. Each unit is composed of four cells, each having a grate area of 36 sq.ft. The working capacity of each unit is 67.2 short tons per 24 hr. burned to "a hard, innocuous and vitreous clinker," says the *Surveyor*.

Clinker is hauled from the destructor to the crusher in trucks pulled by an electric-battery motor. A double-roll crusher is used, adjustable to the desired size of product. The crushed clinker passes through a screen-type magnetic separator and then to a 4 x 18-ft. screen which grades the crushed clinker and delivers it into corresponding compartments in a hopper. The salvaged paper is conveyed by suction to baling presses. Cans are detinned and then baled by two hydraulic presses. Electric power for plant operations is generated from steam produced by heat from the destructor.

From Job and Office

HINTS THAT CUT COST AND TIME FOR THE CONTRACTOR AND ENGINEER

Skillful Blasting of Holes Through Tunnel Under 30-Ft. Water Head

METHODS of making the final blast in tapping by tunnel a lake with a rock rim about 50 miles from Denver, Colo., for irrigation, deserve notice because of the rarity of recorded operations of this kind. A profile

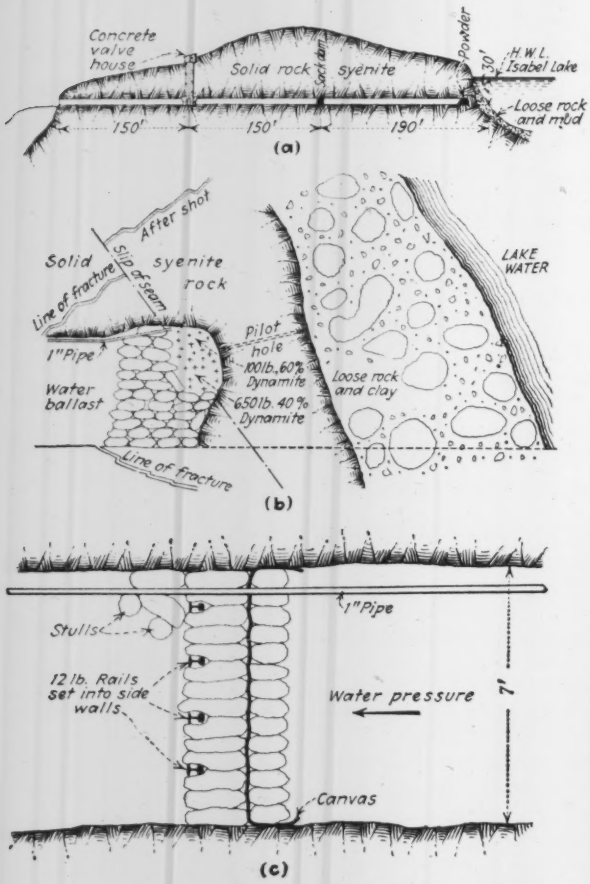


FIG. 1—METHOD OF HOLING-THROUGH TUNNEL INTO LAKE

of the tunnel is shown by Fig. 1*a*; its 5x7-ft. bore was driven by regulation methods until a 6-ft. pilot drill hole showed that solid rock had been penetrated. Soundings had shown that at this point the ledge was covered with some 12 ft. of boulders and clay. The line of the tunnel was 30 ft. below water surface. The blasting problem was to break out against this water head 6 ft. of solid rock and 12 ft. of talus. The method is shown by Fig. 1*b* and *c*. Previously the valve, 36 in., and the valve shaft shown by Fig. 1*a* had been built. The theory of the engineer, Fred A. Fair, Boulder, Colo., was that, using water ballast and a quick blast, a small charge would hole through to the lake as the water ballast, for the firing period, would act substantially as solid rock.

Sketch *b* of Fig. 1 shows the placing of the charge and sketch *c* the construction of the temporary bulkhead to hold the water ballast. The 1-in. pipe was to drain the air out of the tunnel as it filled with water from the pilot drill hole. The blast worked perfectly, tearing out a cone of rock as indicated by Fig. 1*b*.

The essential elements of the operation to be emphasized, it is apparent, were: (1) a quick blast, hence the 60 per cent dynamite and Cordeau; (2) a volume of water ballast which would act as a solid for the period of explosion; and (3) a bulkhead holding water and likewise weak enough to collapse under the blast and built of materials that would sink and not clog the control valve.

This account is condensed from an article in *Compressed Air Magazine*, June, 1926.

"Horn-Gap" Guides for Cable Under Tie-Down on Incline

THE incline built for use in constructing the penstock on the Balch hydro-electric project in California has one low spot or bench where there would be a long span in the hoisting cable if no overhead frame were provided to tie it down. A timber frame was accordingly built and anchored down solidly, as shown in the accompanying illustration. Because of the

INCLINE HOISTING CABLE PASSING UNDER TIE-DOWN

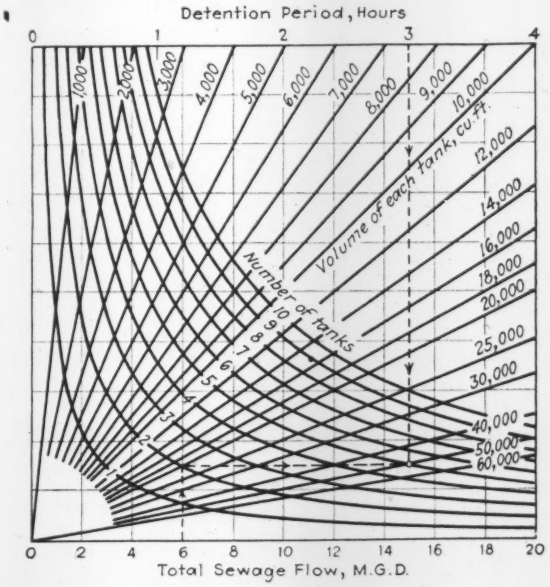
length of the incline and in order to make sure that the cable always comes to a bearing on the roller in the tie-down, two 8-ft. lengths of 2-in. pipe were bent and bolted into place as shown, the arrangement bearing some resemblance to an inverted form of the "horn-gap" lightning arrester commonly used on transmission lines. The scheme has operated successfully for some time.

Detention Periods for Sewage Tanks Operated in Parallel

By R. T. Regester
Junior Civil Engineer, Bureau of Sewers, Baltimore, Md.

THE number and capacity of settling tanks for sewage-works depends primarily upon the flow to be handled with a given detention period determined for efficient removal of settleable solids. The accompanying diagram was prepared to facilitate the design and operation of various layouts with parallel operated tanks.

As an example in the case of design, assume the sewage flow from a city is 6 m.g.d, and the selected detention period is three hours, then from the diagram it is readily seen that two tanks each with 50,000 cu.ft. or four tanks each 25,000 cu.ft. liquid capacity will suit the conditions. Or if the tank volume is decided upon, the number of units required may be easily determined. In the case of operation where the volumes of the tanks



DETENTION PERIODS FOR SEWAGE SETTLING TANKS OPERATED IN PARALLEL

are known, the number of similar units to be placed in service as the flow increases in order to maintain a constant detention period may be noted quickly. The diagram can be used for flows greater than those shown by multiplying both flows and tank volumes by the same constant. That is, for a flow range from 0 to 400 m.g.d. the corresponding range of volumes would be 20,000 to 1,200,000 cu.ft., the constant being 20.

Acknowledgments are due to C. E. Keefer, engineer of sewage disposal, Baltimore, for helpful suggestions.

Advantage in Building Draft-Tube Forms in Advance

IN the construction of the Horse Mesa power and storage project in Arizona one of the first pieces of carpenter work done after the camp was constructed and work on the dam began in earnest, was the construction of forms for the draft tubes. These forms were built several months prior to the stage of the work at which they could be used and during this time were stored in the open as shown in the picture.

DRAFT-TUBE FORMS BUILT IN ADVANCE ON THE HORSE MESA PROJECT

In this part of Arizona there was no danger that the forms would be wet by rain during the summertime. Advance construction afforded an opportunity to try out carpenter crews, select the most capable men, and get this part of the work, which requires considerable care and attention from the foreman, done at a time when there was no rush, thus avoiding the delay and extra cost that often attends work hurriedly done at the last moment.

Lightning Protection for a Concrete Lined Oil Reservoir

A LARGE oil reservoir recently completed by the Southern Pacific Co. near Tracy, Calif., has been provided with four steel towers as a means of reducing the danger of lightning striking the reservoir and setting fire to the oil. The reservoir is a 600x1,200-ft. elliptical concrete-lined bowl with a depth of 30 ft. and a capacity of 3,000,000 bbl. Since the recent disastrous oil fires, noted editorially in *Engineering News-Record*, May 6, p. 715, special attention has been given to lightning protection for oil reservoirs and extensive experiments have been made with models in the high-voltage laboratory of the General Electric Co.

Based largely on the results of these experiments it was decided that the most effective protection would be afforded by grounded steel towers, 150 ft. high, placed 100 ft. away from the edge of the reservoir on the axes of the ellipse. The experiments indicated that such towers would take all direct hits. Tests are now under way as to the desirability of a wire net suspended between the towers.

At the Tracy reservoir the water table at the present time is about 4 ft. below the bottom of the reservoir. Each tower is grounded by means of four 20-ft. lengths of 1¼-in. pipe with special drive points and a top connection such that the ground around the pipe can be periodically moistened. The roof of the reservoir consists of wood sheathing with a covering of composition roofing sloping from the center toward ends and sides sufficient for drainage only. The concrete lining is 4 in. thick, reinforced with wire mesh which is overlapped 6 in. at the joints and firmly connected. Bare stranded No. 1/0 copper cable leads brazed to this mesh are brought out every 100 ft. on the ends and 50 ft. along the sides to permit grounding if this is found desirable. Precautions were taken that no reinforcing protruded into the oil, especially on the steps carrying the wooden joists that support the roof.

Getting the Maximum Parking Use of Semi-Business Streets

IN ORDER to provide the maximum parking space in semi-residence business districts, thereby releasing to moving traffic a large width of the street, the city of Dallas, Texas, restricts the sidewalk area to a 6-ft. strip immediately adjacent to the established building line. Inasmuch as the pedestrian traffic in the neighborhood is not large, the 6-ft. sidewalk width has been found sufficient. The area between the sidewalk and the curb, which in most cities is usually reserved for trees and telephone poles, is thus made available for either vertical or oblique automobile parking.

At street intersections sidewalks are carried 10 or 12 ft. beyond the building line and their ends enclosed with circular curb. A variation of carrying both sidewalks beyond the building line is had by extending only one sidewalk, but "mushrooming" the end. This forms a quadrant which serves both as a safety island for pedestrians crossing the street either way and to keep moving traffic away from the curb.

These safety islands also offer a convenient spot for the placement of street names and block numbers. Street numbers are 2½ in. high and stenciled in black upon a white background. These street numbers are easily seen by a driver merely by his slowing up slightly.

From Job and Office

HINTS THAT CUT COST AND TIME

This work has been done under the direction of A. E. Kingsley, city engineer of Dallas, Texas.

The same system of street naming is followed in Colorado Springs, though block numbers are omitted. Frank O. Ray, city engineer of Colorado Springs, states that the cost of eight markings at each of 25 street intersections, applying a white coat one day and stenciling in black the next was: ½ gal. zone paint, $1.50; 1 qt. lamp black, $0.25; 2 days' labor charge, $9. For the 200 markings this made a total cost of $10.75, or 5.375c. each. A set of interlocking brass stencils with separate letters cost $2.50.

Tar Heater for Expansion Joints

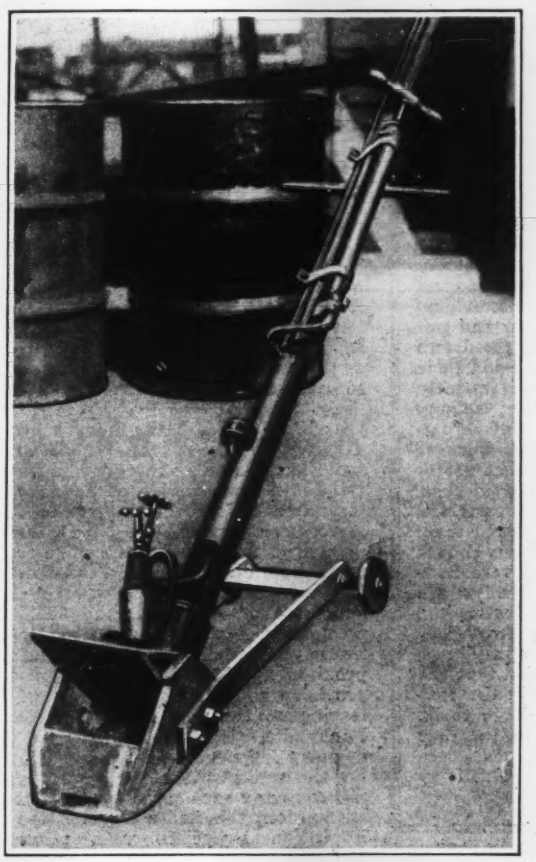
REHEATING tar in expansion joints and cracks in concrete roads is achieved with great facility by a device built by the welding operator for Kern County Road District No. 4, Calif. With his cutting and welding blowpipe, this welder manufactured the portable oil-burning heater pictured herewith. The heater is made with a handle of 2-in. steel pipe capped at both

METHOD OF THROWING LITTLE USED AREAS INTO PARKING SPACE, DALLAS, TEXAS
Street names and block numbers easily seen from automobile.

From Job and Office

FOR CONTRACTOR AND ENGINEER

ends and fitted with a filler plug at the top and an ordinary kerosene burner at the lower end. The flame plays down on the plate forming the bottom of the box which



OXYACETYLENE WELDED TAR REHEATER

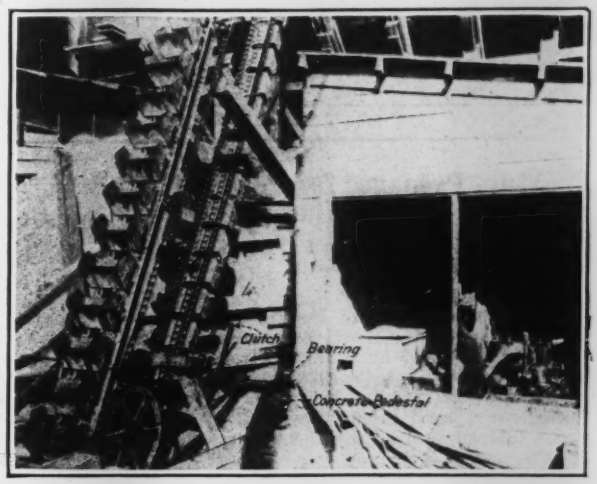
is built entirely of ½-in. material. The handle serves as the kerosene reservoir. Air pressure is supplied by the tire pump attached to the handle.

In operation, the tar is poured as usual. Later this burner is pushed slowly over the tar-filled expansion cracks and the heat radiating through the bottom plate melts the tar down to the bottom. Thus, the subgrade is much less liable to become saturated through surface water seepage in expansion joints and cracks because the tar is not allowed to bridge over in being poured, but penetrates to the bottom of the slab.

Old Motor Car Engine Drives Bucket Conveyor

THE POWER unit used to operate an elevating bucket loader placing aggregate in a storage bin during the construction of the new Kansas City filtration plant consisted of a 1917 model Chevrolet motor car engine that had been ostensibly ready for the junk pile.

The engine, transmission and drive shaft, minus the differential, were left in the frame which was bolted



ELEVATOR HITCHED TO OLD AUTOMOBILE ENGINE

to two 12x12-in. timbers. To the original 1¼-in. diameter drive shaft, which was 38 in. long from the transmission, a 40-in. shaft 2¼ in. in diameter was connected by a 4-in. flange coupling. A hand-operated clutch was attached to the end of the shaft as shown in the illustration. Box bearings resting on concrete pedestals supported the shaft on the extreme end and between the clutch and the transmission. A 40-gal. water tank and the necessary piping were substituted for the radiator. The motor was started in low gear, shifted into second, and operated in high. The contractor using this apparatus was the Chanute Construction Co., Chanute, Kan., with Wirt Seaver as general superintendent.

Job and Office Notes

Engineers Should Record Their Experiences more generally, according to an engineer commenting recently on an article in the "Job and Office" section of *Engineering News-Record*. A part of his letter is as follows:

"I think more engineers should make an attempt to record their experiences and methods in the technical press, either in the form of a technical news story or a brief paper. Frequently I have the inclination to write such, but the lack of time prevents realization of my desire. Also, like most engineers, I approach the preparation of a paper with a certain grimness due perhaps to a feeling of inability to express myself clearly in writing.

"In reflecting on this problem of self expression, it has occurred to me that engineers as a class are perhaps more clam-like than their obligations as professional men and citizens give them moral right to be. For this reason, I am making a conscious effort to acquire greater facility in writing and speaking, and am encouraging all engineers with whom I come in contact to write something."

Leaks in the Large Steel Conduits conveying water from the Pequannock River to Newark, N. J., are repaired by plugging, capping, and electric welding, according to a paper read before the New York Section of the American Water Works Association on March 25 by John A. Foulks, formerly chief engineer of the Water Department of Newark, N. J. The holes, caused by outside pitting, are closed with pine plugs. After a very brief interval to allow the wood to become watersoaked and swell, the plug is sawed off close to the shell of the pipe. A steel patch is then placed over the plug, tacked on at four points and then secured all the way round by electric welding. The cost of making these repairs is approximately $2 per foot, which covers everything but the excavation and backfill. This includes repairing holes and filling in all pits, cleaning, recoating, materials, labor and equipment depreciation.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Program Prepared for Power Conference at Basel

Sectional Meeting of World Power Conference to Meet in Switzerland

The technical program for the sectional meeting of the World Power Conference, to be held at Basel, Switzerland, Aug. 31 to Sept. 12, 1926, includes the following: (A) Utilization of Waterpower, and Inland Navigation; Under this subject there will be a general discussion, including flow of water and amount of deposit in rivers as a function of time, influence of river and lake regulation and dams on the flow. Under technical details there will be discussion of the civil engineering features of water power, hydraulic machinery, electrical machinery and switchgear; and under inland navigation the subject of civil engineering in construction, barges and equipment. There also will be a discussion of the economic considerations in the production of power, and the relation between water power and inland navigation.

(B) Exchange of Electrical Energy Between Countries: There will be a general discussion under this head of the particulars of existing and projected exchanges, of the factors which make the exchange of electrical energy difficult, and the influences of the exchange of energy on the cost of production.

(C) The Economic Relation Between Electrical Energy Produced Hydraulically and Produced Thermally: This question is to be discussed with particular reference to completed or projected installations, so that the conclusions will be of particular value.

(D) Electricity in Agriculture: This discussion will include technical descriptions of the various possible applications of electrical energy to agriculture and economic considerations.

(E) Railway Electrification: This discussion will include a general discussion and a technical session on power stations, converting and transforming stations, line equipment, and locomotives and rolling stock. Economic aspects also will be considered.

American Representatives

John W. Leib will preside at the September 6 session of the Basel conference. The Swiss committee recently requested the American group to select the presiding officer for the date mentioned. Mr. Leib was chosen and has accepted the honor.

O. C. Merrill, the chairman of the American group, will sail from New York Aug. 7. He already has forwarded all of the American papers. The titles of these papers and their authors are: "Utilization of Water Power, and Inland Navigation," by Col. Hugh L. Cooper; "Exchange of Electrical Energy Between Countries," by Col. William Kelly; "The Economic Relation Between Electrical Energy Produced Hydraulically and Electrical Energy Produced Thermally: Conditions Under which the Two Systems Can Work Together with Advantage," W. E. Mitchell, vice-president Alabama Power Co., and John M. Gallalee, University of Alabama; "Electricity in Agriculture," Dr. E. A. White, director, Committee on the Relation of Electricity to Agriculture; "Railway Electrification," W. S. Murray; "National Aspects of the Study of Water Reserves," N. C. Grover and John C. Hoyt.

Orders for the transcript of the proceedings which must be placed in advance, are being handled by Mr. Merrill.

Engineering Fifty Years Ago

From *Engineering News*, July, 1876

In nearly every period of high water we hear of some accident to boats navigating the Mississippi River in attempting to pass the bridge draws. The bridges have become so numerous that river men regard them as the chief obstacle to navigation on that river and far more destructive than sand bars, etc. Indeed, it has become the common custom for boats to lie up and not attempt the passage of the draws in periods of high wind and rafts and barges are very frequently destroyed on the piers at any water. The propriety of throwing an unlimited number of bridges across navigable streams we do not propose to discuss, that already having been decided in our courts, but it would seem that additional safeguards should be thrown around the vessel interests which the railways are so much interested in destroying. Of course there are two sides to the question to be considered, but it can be safely said that the railways will always, in the construction of bridges, have to be held with a strong rein, in order to conserve interests which are directly in opposition to railway monopoly.

New Drainage District Organized in Oklahoma

The Deep Red Drainage District No. 1, located 3½ miles north of Grandfield, Okla., has been organized for the construction of about 8 miles of drainage ditch at a cost of $100,000. Surveys and plans are being prepared by Dwight E. Powell, county and city engineer at Frederick, Okla.

WASHINGTON NOTES

COLONEL C. McD. Townsend, who has been serving until recently as district engineer at New Orleans, has consented to serve as engineer for the Gulf division until Colonel William P. Wooton who has been assigned to those duties can conclude his present work as an instructor at the Army War College. Colonel Wooton also will be chairman of the Board of Engineers which will report on the feasibility of spillways as a means of reducing flood heights on the Mississippi River below Red River. This report, Colonel Wooton believes, involves engineering problems fully as interesting and important as those covered in the Wooton-Bowden report on the St. Lawrence.

A STRUGGLE between railroads of the Southwest for permission to build into the almost virgin territory of the South Plain region of Texas is being aired before the Interstate Commerce Commission. In March an examiner of the commission made a report upon the proposed railroad construction in that part of Texas, as noted in our issue of April 8, page 587. He recommended the construction by the Texas, Panhandle & Gulf R.R., of approximately 303 miles, with certain provision as to trackage rights and the leasing of the new line. The Texas, Panhandle & Gulf Co. is a new and presumably independent company. Opposing the authorization of construction by this company are subsidiary lines of the Burlington, the Santa Fe, and the St. Louis-San Francisco with plans of their own.

The Interstate Commerce Commission is hearing oral arguments in the case before giving its decision.

VERY general opposition is being evidenced toward the proposed general survey of rivers as proposed in the rivers and harbors bill. In compliance with a provision in the 1925 river and harbor bill, the Chief of Engineers furnished a long list of important rivers on which engineering data is incomplete. Major General Harry Taylor, under whose direction the report was made, fears that the opening of general surveys on many rivers may result in demands that development be postponed until the survey is finished. The surveys necessarily would proceed slowly as the appropriations, in all probability, would be quite limited.

American Engineering Council is opposed to the surveys and O. C. Merrill, Executive Secretary of the Federal Power Commission, thinks the whole water power industry is against the provision as it appears in the pending bill.

Mr. Merrill long has been urging that Congress authorize the expenditure of

license fees for river surveys as provided in the act. At present the license fees are being converted into the Treasury as miscellaneous receipts. He thinks, however, that these studies should be confined to rivers about to be developed or on which some question has arisen. The actual work would be done by the Corps of Engineers and the U. S. Geological Survey.

Just at this time, for instance, there is great need for definite data as to the effect on navigation in the Kanawha River of power waves set up in New River and the effect of diverting one of the tributaries of New River onto the Atlantic watershed. No funds now are available for thorough studies of these questions. Another example is the Cumberland where the controversy over its use for power purposes has been handicapped by the absence of definite data of an engineering character concerning the flow and the effect of diversion upon the beauty of the falls.

The river and harbor bill is on the Senate calendar but an effort will be made on the floor at the December session to amend the paragraph providing for the surveys.

THE International Joint Commission has granted the application of the St. John River Power Co. covering a power development in New Brunswick, but affecting the international sector of the river.

The Commission a year ago authorized the New Brunswick Power Commission, a public agency, to develop this project. Subsequently, however, the people of New Brunswick voted against government ownership and operation which made it necessary to grant new authority to the private company which now proposes to undertake the work.

The application was granted with the understanding that 2,000 hp. are to be exported to Maine for use in the United States. While all of this power is intended for use at a paper manufacturing plant, some discussion was occasioned as to the possibility of the distribution of the power at some later date. The condition originally provided only for export of power for Maine. Some question arose as to whether or not that would permit the distribution of the power beyond the confines of that state. This rather remote contingency was provided for by the phrase "for use in the United States."

The applicant expects to construct its power house at Great Falls and to carry out the project in the same manner proposed by the provincial commission, except the water is to be led to the power house by a tunnel instead of a surface canal. The possibility of having to run a second or even a third tunnel with the increase of storage on the river was mentioned in the course of the proceedings.

MAJOR M. P. FOX, who is in charge of the rivers and harbors desk in the office of the assistant Chief of Engineers, has returned from Belgium, where he attended the Brussels meeting of the Permanent International Association of Navigation Congresses.

DeBerard Joins Chicago Regional Planning Association

Effective Aug. 1, 1926, W. W. DeBerard, western editor, *Engineering News-Record*, has been granted a leave of absence to become chief engineer of the Chicago Regional Planning Association.

The association is a corporation not for profit which has enlisted the support of the county boards, the Chicago Commonwealth Club, University of Chicago, Northwestern University, Union League Club, the City Club, many cities and villages, chambers of commerce, firms and individuals. D. H. Burnham is president, B. F. Affleck treasurer, and Robert Kingery, secretary. The area covered is that territory within commuting distance of Chicago, roughly a 50-mile radius covering more than 7,000 sq. miles of land in three states and 15 counties, and including 250 cities and villages, 70 park boards, 40 plan commissions, 8 sanitary districts and a large number of drainage districts. Co-ordination of the construction activities of the many authorities now planning and carrying out public and private works projects is the principal purpose of the association, so that orderly and connected systems of highways, sewers, parks and other public and private works may be developed. This is being accomplished through joint agreement of these authorities in committees on each of the twelve major subjects being studied. Such general drawings are being made as will aid officials in scheduling their programs. Progress and special reports are issued as needed for public education. Ultimately these reports may be assembled into a master volume covering the entire regional project.

Mr. DeBerard has been connected with *Engineering News-Record*, and its predecessor, *Engineering Record*, since 1910, all of that time in charge of the Chicago editorial office. He was graduated from Massachusetts Institute of Technology in 1901 and from that time until 1910 was engaged in engineering work, mainly on water and sewage projects in Philadelphia, Harrisburg, Pa., Columbus, Ohio, Oakland, Calif., Denver and New York City, in the latter case with the Metropolitan Sewerage Commission of New York. He was also for a time in the U. S. Reclamation Service. Mr. DeBerard was a member in 1924-5 of the Engineering Board of Review of the Sanitary District of Chicago. His headquarters with the Regional Planning Association will be in the Burnham Building, Chicago.

Highway Engineering Course at Ohio State University

The Ohio State University announces the opening of a course in highway engineering, starting at the opening of the school year in September. This is the direct result of action taken by the Ohio Automobile Association at its annual convention held in Columbus in May. The course will be available to students in engineering after they have completed three years of college work.

Building Inspectors Now Required in Washington, D. C.

Under a new rule adopted by the commissioners of the District of Columbia, the owner of a building under construction must employ an inspector approved by the District building inspector. The rule applies to the construction of large buildings and all places of assembly in the District of Columbia: buildings containing more than 20,000 sq.ft. of reinforced concrete or more than 100 tons of structural steel, and also theaters and other places of assembly regardless of size. The rule carries out a recommendation made by the Washington Society of Engineers.

Columbia River Commission Holds First Meeting at Spokane

An organization meeting of the Columbia River Commission was held in Spokane, Wash., July 12. Dr. Elwood Mead, the Commissioner of Reclamation, was elected chairman. Dr. Mead represents the Secretary of the Interior on the board.

An act of Congress passed at the recent session provides that the Secretary of the Interior may co-operate with the states of Washington, Idaho, Oregon and Montana, in the allocation of the waters of the Columbia River.

One of the purposes of the study is to determine the amount of water supply necessary for the Columbia Basin Irrigation project. The Board will undertake economic and other investigations, including the power possibilities of the stream. Another object is to report on the type of district organization best suited to handle the reclamation project.

Missouri Sewer District Law Declared Invalid

Holding that it was a special or local law the Missouri Supreme Court has ruled invalid the act passed by the last legislature making provision for the establishment and maintenance of sanitary sewer districts in the congested parts of St. Louis County. The decision was written by Judge W. W. Graves and passed on by the court en banc. Judge Graves held that the situation could only be relieved by the passage of a general law that would be applicable to all of the other counties of the state.

The suit was filed by Attorney General N. T. Gentry to remove Fred L. Armstrong, Adolph Friedler and Charles L. Wilson as supervisors of the Northwest Maplewood Sewer District organized under the new law. It was brought to test the validity of the new act at the request of the county authorities and the prospective purchasers of bonds for the district.

Under the act held invalid, known as the Ralph Law, sanitary sewer districts were organized under supervision of the circuit court and permitted the issuance of bonds to be paid off in twenty years. Under the old law sewer districts were under the supervision of the county court and sewer assessments had to be paid within five years.

Methods of Reducing Accidents Discussed at Washington

Plans looking toward an intensive study of physical hazards in industry in order to develop remedies and remove the causes of accidents were discussed in Washington July 14, 15 and 16, at the Industrial Accident Prevention Conference called by Secretary of Labor Davis.

Resolutions were adopted at the closing session favoring a plan of detailed industrial accident reports to some department of each state, these in turn to be forwarded to the United States Department of Labor. A bill to create in the Bureau of Labor Statistics a Division of Safety, to gather and study accident statistics, is pending before Congress with a favorable report in each branch.

Speakers at the conference stressed the need of more adequate statistics in order to more accurately judge the cause of accidents in industry, which Secretary Davis estimated are costing 23,000 lives and 2,500,000 injuries annually. Frank Morrison, secretary of the American Federation of Labor, using Secretary Davis' further estimate that 85 per cent of industrial accidents are preventable, said that 19,550 are killed needlessly and 2,125,000 injured needlessly each year. He estimated the annual wage loss due to accidents at a billion dollars.

Experience of large corporations, notably the United States Steel, in reducing accidents, were cited by various speakers. Others, including Lewis A. DeBlois, of the National Bureau of Casualty and Surety Underwriters, pointed out that reduced accident rates bring dividends in increased production and lower labor turnover. Safety work in mines was told by W. W. Adams, of the U. S. Bureau of Mines, and T. F. Jennins, of the Utah Copper Co. Need of proper lighting was the subject of W. H. Rademacher, of the Edison Lamp Works.

Lehigh to Grant Only Bachelor Degrees to Graduates

Beginning with the entering class next fall, Lehigh University will stop granting degrees of civil, mechanical, electrical, or chemical engineer to the graduates at the end of their four-year course and will grant them bachelor of science degrees in the various branches of engineering instead. Engineering degrees will be granted to these graduates after five years of "acceptable practical experience in responsible charge of work after graduation and the submission of a suitable thesis."

The announcement states that "Engineers cannot be trained by a purely academic process." Coincident with the change will come a revision of the courses of study by which greater emphasis will be placed upon the fundamentals of engineering, mathematics, physics, and chemistry, and less emphasis will be placed upon specialized details of engineering practice. The revisions will include the addition to the courses of such subjects as social science, arts and business administration.

Hearing on Ry. Electrification in New York City

The Public Service Commission of New York, on July 19, acting under authority of a law passed recently authorizing it to grant an extension of time not exceeding five years for steam railroads operating within New York City to complete electrification of their lines in compliance with section 53-a of the Public Service Commission law, announced its decision upon the applications of five railroads for such extension.

The New York, New Haven and Hartford R.R. was given an extension until July 1, 1928. Work remaining to be done is on that part of the Long Island Railroad which the New Haven operates under trackage agreements between Fresh Pond Junction and Bay Ridge, and the freight tracks from Port Morris across Hellgate Bridge to Fresh Pond Junction.

According to a memorandum by Chairman Prendergast it was brought out at the hearing that delivery and installation of equipment, aside from that on the Long Island freight tracks, cannot be accomplished before July 1, 1928. Eighteen electric locomotives now on order can not all be delivered at one time. In addition it will be necessary to have Diesel locomotives of the oil electric type and experimental work in developing these engines in powers over 1,000 horse power has been going on continuously to the end that suitable engines for the company's service will be delivered for experimental purposes in single units.

Staten Island Lines

Petition by the Staten Island Rapid Transit Co. for a five years' extension was denied. The company's passenger facilities have been electrified. The freight service has not as yet been electrified. The larger percentage of the freight service is interstate traffic, coming from western points by way of New Jersey. Chairman Prendergast says electrification of such through freight service would require rebuilding of the Arthur Kill Bridge at a cost said to approximate $6,000,000, and electrification of terminals and other facilities, approximately $4,000,000. The company claimed that for freight service the present type of Diesel engine is impractical, such engines being unsatisfactory for any except slow switching operation. It insisted that a heavier type of locomotive is necessary in order to develop sufficient tractive power.

Representatives of the company announced that it was the intention to continue to investigate improvements in such electrical type of engine. It was stated, in view of the circumstances and the costs incidental to complete electrification, that the company, if compelled to elect between spending the necessary amount of money for electrification, or abandoning its freight service on the Island, would abandon such service.

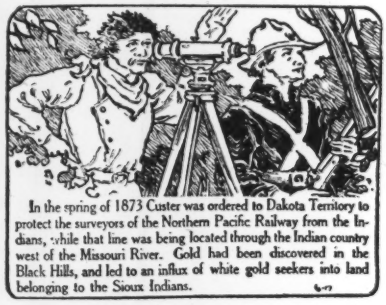
Petition by the Degnon Terminal Railroad Corp., operating a terminal line in the Borough of Queens, a distance of about half a mile, for an extension of five years was denied. The Commission approved the use of an oil-electric locomotive on Dec. 17, 1925.

Petition by the Brooklyn Eastern District Terminal for a five years' extension was also denied. The company transports freight on car floats between its terminal stations and trunk line roads entering the port of New York and receives freight at terminal stations in Brooklyn and Long Island City. The Commission approved the use of oil-electric locomotives on Dec. 30, 1925. The company at the hearing insisted that it was not practicable to substitute the Diesel oil-electric engine; that anthracite burning locomotives are less objectionable and further that the company is not prepared to assume the financial responsibility of complete electrification.

The Pennsylvania R.R., covering operation in its Sunnyside Yard in Queens and 37th Street and North Fourth Street yards in Manhattan was given an extension until January 1, 1927. Six additional locomotives are in service in the Sunnyside yard and six additional locomotives will be received late in the fall. Evidence on the hearing before Chairman Prendergast was to the effect that it was a physical impossibility to get the locomotives at an earlier date. Diesel electric engines have been ordered to replace the steam locomotives in the two other yards and delivery is promised late in the fall.

RANDOM LINES

No Wonder the Northern Pacific Has So Many Curves



In the spring of 1873 Custer was ordered to Dakota Territory to protect the surveyors of the Northern Pacific Railway from the Indians, while that line was being located through the Indian country west of the Missouri River. Gold had been discovered in the Black Hills, and led to an influx of white gold seekers into land belonging to the Sioux Indians.

From a syndicated story in the *Worcester Evening Post*

* * *

Bedrock Disappearing

"Howard N. Butler, of a Sanford well drilling concern, says that few people imagine the serious character of the dry weather that has prevailed in the state for the last three or four years.

"In drilling wells," said Mr. Butler, "we find that the surface is drier *and that the ground extends to a greater distance down the drill holes* than in the past."—*The Sanford Express.*

This should make work for underpinning concerns extending foundations down to overtake the disappearing bedrock.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Providence, R. I., Sept. 14-17, 1926.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Pinehurst,, N. C., Nov. 8-12, 1926.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

THE ASPHALT ASSOCIATION, New York City; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

The International Mid-Continent Engineering meeting is to be held this year at Duluth, Minn., August 12-14. The program includes a trip over the Duluth Iron Range on the 13th.

Personal Notes

C. N. CONNER, recently chief engineer, Mexican National Highway Commission, has been designated chairman of the Earth Roads Investigation being conducted under the auspices of the Highway Research Board, according to an announcement made by Charles M. Upham, director of the board. Mr. Conner will give full time to this work continuing the investigation of intermediate type road treatments and experiments from the preliminary stages through which it has thus far been conducted.

After graduating from Tufts College in 1908 Mr. Conner was for two years on construction with the New York Central R.R., following which he was for three years assistant engineer with the Bureau of Public Works, Philippine Islands. Later he was assistant engineer with the War Department and then with the Navy Department.

He then became assistant engineer with the Delaware Highway Department following which he was for three years state construction engineer with the North Carolina Highway Commission and for one year state construction engineer and head of the testing and research laboratory of that organization. During the past year he has been chief engineer of the Mexican National Highway Commission.

COLONEL GEORGE M. HOFFMAN, recently division engineer, U. S. Engineer Corps, Gulf Division, New Orleans, La., and a member of the Mississippi River Commission, has been assigned to command the First Engineer Combat Regiment at Fort Du Pont, Del.

RICHARD M. RUMSEY has been appointed county superintendent of highways for Niagara County, New York, with headquarters at Niagara Falls, N. Y., succeeding the late Thomas M. Brennen; Mr. Rumsey had previously been engaged by the state highway department.

A. B. NORMANDIN, engineer with the Department of Public Works, Quebec, has been elected chairman of the Quebec branch of the Engineering Institute of Canada.

A. R. SENTER, who has been assistant county engineer of Cloud County, Kansas, has been made county engineer, with headquarters at Concordia.

O. L. MOORE, formerly engineer of the Inspection Bureau, Universal Portland Cement Co., has been appointed engineer of tests in that company. Mr. Moore is a graduate of Carnegie Institute of Technology and has been connected with the Universal Portland Cement Co. for the last 12 years.

W. S. TOMLINSON, city engineer, Columbia, S. C., for the last five years, has submitted his resignation, to become effective upon the election of a successor, and plans to give all of his time to his private business as president of the Tomlinson Engineering Co., organized about ten years ago. He has been engaged in engineering work for 15 years and previously worked on the Quebec bridge over the St. Lawrence River.

D. D. GROSS, recently appointed to the position of head of the Municipal Water Company of Denver, Colo., has been in the engineering department of the water company for the past 22 years, 14 of which were with the Denver Union Water Company, the predecessor of the present municipal company.

CHESTER N. REITZE has resigned as Pacific Coast district manager of the Portland Cement Association to become vice-president and general manager of Superior Portland Cement, Inc., with offices in Seattle.

J. E. JELLICK, district engineer for the Portland Cement Association at Los Angeles has been made Pacific Coast district manager succeeding Mr. Reitze, and will make his headquarters at San Francisco. Mr. Jellick is succeeded by A. H. POTTS, one of his former assistants.

L. M. GRANT, formerly general manager of the Continental Pipe Manufacturing Co., Seattle, has been appointed superintendent of the water department of that city. Mr. Grant, in his work with the pipe company, designed and built several of the largest wood stave pipes in the west, the diameters of which ranged up to 14 ft.

WILLIAM C. E. BECKER, former building commissioner for St. Louis, Mo., recently became associated with FREDERICK C. TAXIS of that city in the practice of civil engineering. The new firm is known as Taxis & Becker. It has offices in the Chemical Building, St. Louis. Previous to his appointment as building commissioner Mr. Becker was employed as a structural engineer in the bridge and building departments of various railroads. Mr. Taxis has practiced for more than twenty years in St. Louis. He is a member of the Plaza Commission.

Obituary

A. W. SMITH, city engineer of Peru, Ind., died in that city on June 29.

GENERAL HENRY T. DOUGLAS died at his home in Providence Forge, Va., on July 21, aged 88 years.

OBERLIN SMITH, a past president of the American Society of Mechanical Engineers, died at his home at Bridgeton, N. J., on July 19, in his 87th year. At the time of his death he had been president and principal owner of the Ferracute Machine Co. for 63 years.

GEORGE W. WINCKLER, retired civil engineer, died recently at his home in Toronto, Canada, in his 82nd year. Mr. Winckler was born in Cochin, India, in 1844. He served in the Public Works Department of the British Indian Civil Service. In 1893 he retired and moved to Canada.

L. B. LANDMAN, who was general manager of the Jefferson City, Mo., Water Co., was drowned some time between July 4 and July 7 in the Missouri River near Algoa, near Jefferson City. It is believed that he fell into the river while inspecting some new construction now under way for the water-works of Jefferson City. He was 42 years of age.

SAMUEL BROWNLEE FISHER, consulting engineer, Missouri-Kansas-Texas Railway Company, died in the railroad company's hospital at Parsons, Kansas, on July 9, following a brief illness. Mr. Fisher was born at Cherry Fork, Ohio, in 1846, and was graduated from Washington and Jefferson College in 1868. For five years thereafter he was employed in locomotive shop work. From 1873 to 1885 he was with the engineering department of the Pennsylvania Company in various grades from transitman to assistant engineer. In April 1885 he went to the Milwaukee & Northern Railroad as chief engineer, later becoming chief engineer of the Minneapolis, St. Paul & Sault St. Marie Railway and in 1893 chief engineer and superintendent of the Everett & Monte Cristo Railway on the construction of its line from the lowlands near Puget Sound to the heart of the Cascade Mountains. In 1894 he went to the Missouri, Kansas & Texas Railway, becoming its chief engineer in 1895, which position he held until in 1912, with the reorganization of the M-K-T Railway, he became chief engineer of construction and chairman of the valuation committee. He was appointed consulting engineer in March 1916.

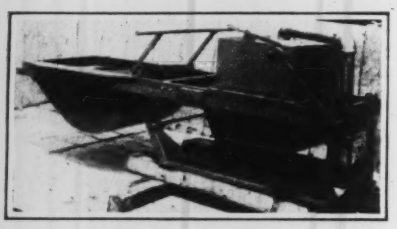
Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Water-Cement Ratio Regulator

A beam scale device for controlling the water-cement ratio in concrete proportioning is being placed upon a commercial basis by John G. Ahlers, 110 West 40th Street, New York City. Mr. Ahlers has experimented with this machine for some time past on building operations in and around New York City and a complete description of its use in this connection was given in *Engineering News-Record*, October 22, 1925, p. 675.

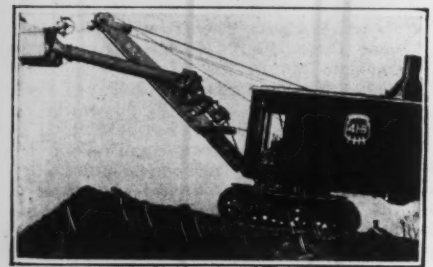
The proportion of water to cement is determined on a basis of comparative weights. The two containers for water and cement are set in a balance frame and by movement of the water tank the water ratio is changed. By a system of sliding weights the necessary compensation for moisture in the aggregate is obtained. The machine is calibrated to 11 set positions corresponding to 11 water cement ratios giving strengths from 1,000 to 3,500 lb. The scale on the moisture compensator reads in pounds of water. Both the position of the tank and the moisture compensator can be locked. The machine is usually mounted directly over the mixer. The illustration shows the equipment as it is now ready for distribution.



A New 1¼-Yd. Shovel

For those jobs of excavation where capacity greater than that offered by a 1-yd. dipper is required, the Bucyrus Co., South Milwaukee, Wis., has recently announced the 41-B, a 1¼-yd. shovel. It has a two part hoist and is quickly convertible to a dragline. The drum speed is the same for both dragline and shovel work, so that a minimum amount of work is necessary in changing from a shovel to a dragline. As a dragline the machine is offered with a 40-ft. boom and a 1-yd. bucket or a 45-ft. boom with a ¾-yd. bucket. Except for the larger capacities and working ranges, this machine is a companion machine to the 31-B, a recent product of the company.

Details of the shovel are box girder boom, outside dipper handles, two part hoist, cast base and revolving frame, and caterpillar mounting.

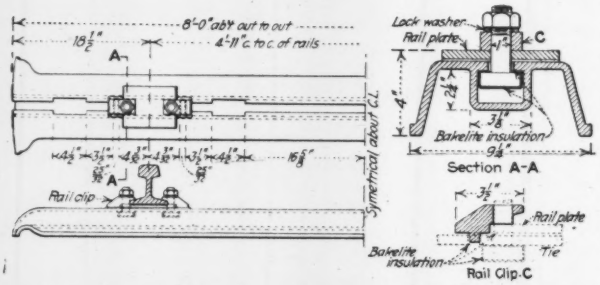


Dump Body on Motor Grader for Maintenance Work

A patrolman operating a Wehr motor grader finding frequent use for gravel for chuck hole filling conceived the idea of mounting a dump body on the rear of his grader. The Wehr Co., of Milwaukee, Wis., attached one of their dump bodies to the rear of their Model C grader for his use and finds that the combination works quite effectively.

Latest Steel Cross-Tie Is Simple in Construction

The latest and most important development that has been made in the Snyder steel tie, now known as the Keystone copper steel tie, has been the elimination of all holes, rivets and other weakening points in the channel section itself. The tie is a special channel section which includes a strong and reliable reinforcement consisting of an inverted central channel or depression with an over-hanging shoulder structure extending over the central channel. The rail fastening device is simple and possesses a positive holding power which is claimed to eliminate disadvantages formerly experienced in other steel tie rail fastenings. The bolts used are fastened from the top of the tie, thus facilitating rapid installation and change of rail.



The Keystone Metal Tie Corp., New York City, manufacturer of this tie, has a new process for rolling steel channels with an over-hanging shoulder structure, and since this method requires but four passes through the rolls, an exceptionally reasonable price on the ties is said to be obtained.

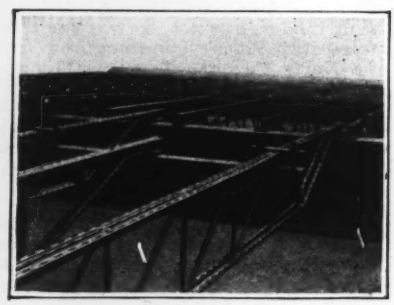
Each end of the tie is in the shape of a "whale-tail," designed to avoid lateral displacement of track while the channel section grips the roadbed, insuring against longitudinal creeping. All parts of the tie, including bolts and clips, have a copper content sufficient to assure a minimum life of fifty years for the tie under normal conditions. Details in the accompanying drawing will explain the manner of construction. The bolts are triple locking, and all strain is taken away from them by the wall of steel on both the clips and the extending shoulders.

An effective insulation of vulcanized cotton fibre for block signal routes is used with these ties. The component parts of the insulation consist of plane surfaces of insulation in direct bearing with plane surfaces of metal. Other advantages of the tie are true and permanent track gauge, assurance of an even bearing surface for the rail, uniform distribution and transmission of loads to the tie by direct bearing and to the ground throughout the whole tie, small deflection under loads, 500 ties per mile of track less required than when wooden ties are used, and reinstallation any number of times without affecting the efficiency of the rail connections.

Welded Trusses Fabricated from Reinforcing Bars

The new truss developed by the Concrete Steel Co., New York City, for use in connection with concrete floor slab and metal lath ceiling construction is to be carried in stock in spans from 4 to 31 ft., the span increasing by increments of 6 in. The truss is of the Pratt type, made up of 5 bars as ordinarily used for concrete reinforcement. Two parallel Havemeyer bars form the top chord and two the bottom chord, while a plain round bar is used for the web members. All intersections are electric welded and the ends of the chords are welded to a tee section, which acts as a bearing plate for the truss. The bottom chord is bent up and rests on the top of this tee section. A double member is used as the first vertical of the truss to give additional strength.

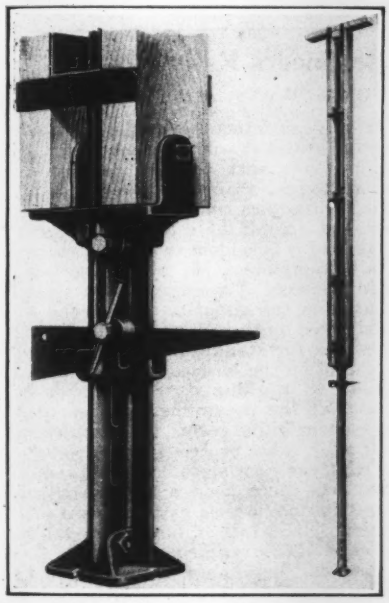
These trusses are intended for use in supporting either floors or ceilings.



When erecting them the trusses are laid on the steel beams or girders and the tee section is clipped to the upper flange of this structural support. For floor construction metal rib lath is laid across the top and fastened to the truss by means of wooden wedges driven through the lath and between the upper chord members. The metal lath ceiling is attached to the under side of the truss by means of wire clips. Where small openings are required in the floor, the company furnishes headers which support a short span. Such an arrangement is illustrated in the accompanying view. As noted, these trusses are carried in stock at the Akron plant ready for prompt shipment and the company's engineers will co-operate with architects, engineering and contractors in designing buildings for using this method of construction.

A New Adjustable Shore

The shore illustrated herewith is a new product of the M. & M. Wire Clamp Co., Minneapolis, Minn. It may be erected either side up and inclined at any angle. The shore has a working load of 4,000 lb. and weighs 57 lb. The



range of adjustment is from 8 in. to 14½ ft. The working parts of the shore consist of a wedge and set screw. These may both be seen in the illustration, as well as an indication of the manner of operation.

New Trolley for Small Hoists

A new motor-driven trolley has been developed by the American Engineering Co., Philadelphia, for use with its ½-ton and 1-ton Class A "Lo-Hed" electric hoists, which have been built heretofore in bolt-suspension and plain trolley types only. The trolley can be supplied with travel speed of 80 or 120 ft. per minute. It can be arranged for remote control, if desired. Any of these hoists now in service can be easily converted into a motor-trolley hoist by adding a new trolley. Only 22-in. headroom is required for the hoist and the trolley, and maximum traction is obtained by driving all four wheels. The three main

castings, from which the hoist and load are suspended, are of cast steel. The spur gear drive is totally inclosed and runs in an oil bath. Hyatt roller bearings are used on all shafts. The motor can be furnishe for d.c. or a.c., either 2- or 3-phase.

Acoustics Improved by Use of a New Plaster

A plaster that is claimed to absorb a great portion of the sound instead of reflecting it was perfected some five years ago at the Riverbank Laboratories, Geneva, Ill., by Dr. Paul E. Sabine. It is known as Sabinite acoustical plaster and has been withheld from the market by the Laboratories until actual job experience should substantiate or disprove the results obtained in laboratory tests.

Announcement is now made that the United States Gypsum Co., Chicago, is to manufacture and market this plaster under an exclusive license. The material comes to the job already sanded and requires only the addition of water. Its covering capacity is claimed to be greater than ordinary plaster and its application involves no greater problems than those of ordinary plaster.

To obtain job experience with this plaster, two rooms at the Riverbank Laboratories, one room at the Geneva, Ill., high school, and auditoriums and radio broadcasting rooms at various points in the United States have been plastered with it. According to Dr. Sabine, these test jobs have shown that the material has performed identically the same as it did in the laboratories.

Business Notes

HORNBLOWER & WEEKS, Boston, New York and Chicago, one of the leading banking houses in the United States, has instituted an advertising campaign in technical magazines announcing its facilities for purchasing the entire bond issues of large and sound American manufacturing plants, railroads and public utilities. The company feels that through these mediums it can reach important business interests who may have security issues to sell, in this way not only increasing its own business, but performing a distinct service to the manufacturer.

REPUBLIC MOTOR TRUCK CO. INC., Alma, Mich., announces the establishment of a system of factory branches on the West Coast extending from Los Angeles to Portland, Oregon. Three of these factory branches have been opened in the past month in Los Angeles to Portland, Oregon. The names of the managers in the present branches are as follows: Los Angeles, G. A. Anderson; San Francisco, K. A. Woodin; Portland, Glenn Harmon. R. H. Spencer is Pacific Coast manager of the entire West Coast branch system. This system is said to have been established in order to give the owners the highest possible type of service which was not possible when dealing with them from the factory. It will in no way interfere with the national distributor organizations but has been established primarily to supplement their service.

STANLEY ADVERTISING CO., New York, announces the acquisition of the Motion Picture Consultants, Inc. The combined organizations will provide an efficient source of supply for industrial, educational and commercial motion pictures.

T. L. SMITH CO., Milwaukee, Wis., has appointed the Arizona Tractor and Equipment Co., Phoenix, as distributors in the state.

CONCRETE SURFACE CORP., 342 Madison Avenue, New York, announces that Samuel Warren, formerly manager of the Atlas White department of the Atlas Portland Cement Co. is now associated with them as technical manager.

WALTER H. VAN WINKLE, president of the Waterworks Equipment Co., New York City, and for many years active in the work of the Waterworks Manufacturers Association died July 16 at Belgrade Lake, Me., following a stroke of apoplexy. Mr. Van Winkle was 69 years old. The company will be continued under the direction of Mrs. Van Winkle who has been in the business for some time.

CHARLES A. COFFIN, founder and for thirty years head of the General Electric Co. as president and chairman of the board of directors, died July 14 at his home in Locust Valley, L. I., N. Y. Mr. Coffin was born in Somerset County, Maine, in 1844. At the time of the organization of the General Electric Co. he came to it from the Thomson-Houston Electric Co., a company which he in connection with others had purchased from Professors Elihu Thomson and Edward J. Houston in 1883 when the company was a small struggling concern known as the American Electric Co. of New Britain, Conn. From this beginning he developed and added to until the time of its consolidation with the Edison General Electric Company of New York to form the present General Electric Company.

New Publications

Steel Deck Roofs—TRUSCON STEEL CO., Youngstown, Ohio, has issued a new booklet entitled "Truscon Roofs of Security," in which are described two types of steel deck roofs—Ferrodeck and I-Plates. Descriptions, illustrations, and specifications are given for both types of this light-weight, fireproof roof decking.

Stadiums — OSBORNE ENGINEERING CO., Cleveland, has issued a 23-p. booklet illustrating the many grandstands and stadiums which have been designed and built under its supervision.

Portable Compressors — SULLIVAN MACHINERY CO., Chicago, has published a new portable compressor catalog No. 83-D. Four sizes, 110, 170, 220, and 320 cu.ft. per minute, direct connected to gasoline engines, are considered.

Pumping Stations—DE LAVAL STEAM TURBINE CO., Trenton, N. J., has just issued a pamphlet describing the Fairmount pumping station at Cleveland. Since the type of turbines and method of operation employed are closely similar to those which could be used in any manufacturing plant where low or moderate pressure steam is required for heating or processing, the pamphlet should have general interest. Besides this, considerable data are given on the geared turbine-driven centrifugal pumps.

Railroad Car Wheels — CARNEGIE STEEL CO., Pittsburgh, describes in a new booklet its light weight wrought steel wheels for freight-car service. Rolling mill photographs are given together with cross-section dimensional drawings of the wheels.

Electric Control — CUTLER-HAMMER MFG. CO., Milwaukee, Wis., devotes its latest publication to the story of the progress made in the development of motor-control apparatus. The booklet, No. C-37, is known as "Industry's Electrical Progress." Much of it consists of examples of production economies through motor controllers. Illustrations are given of different types of controllers in many sorts of plants.

Crane and Foundry Equipment—WHITING CORP., Harvey, Ill., has published a new condensed catalog entitled "Whiting Products," which covers not only its standard line of cranes and foundry equipment, but also various specialties and the products of its subsidiaries.

Douglas Fir—THE WEST COAST LUMBER TRADE EXTENSION BUREAU, Seattle, Wash., has made available a 32-p. booklet on Douglas fir. The text of the booklet is written by Prof. Bror L. Grondal, College of Forestry, University of Washington, and is profusely illustrated with the various uses to which Douglas fir has been put. The text, besides including information on the history, growth and strength of Douglas fir, considers its uses for various interior and exterior applications. Tables given working stresses are included.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
July 22, 1926	$20,694,000	$26,089,000	$46,783,000
July 15, 1926	24,293,000	49,353,000	73,646,000
July 23, 1925	21,739,000	22,391,000	44,130,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	614,198,000	995,771,000	1,609,969,000
1925	586,327,000	726,153,000	1,312,480,000

Bids 17 Per Cent Below Engineers Estimate on Road Jobs

IN THE accompanying table the engineers estimate, on proposals received by the New York State Department of Public Works, Bureau of Highways, for the construction or reconstruction of 51.98 mi. of roads, is compared with the highest as well as the lowest bid. The average bid was found to be about 17 per cent below the engineers estimate of construction cost, although in two instances the difference was as great as 21 per cent. A total of 128 bids were received on twenty projects.

Our Albany correspondent has the following to say regarding the difference between contractors' bids and engineers' estimates:

"When bids for road construction are asked by the New York State Highway Department, included in the proposal is the engineer's estimate for the total cost of construction. For the past four or five years bids received have ranged from 12 to 21 and in some instances 25 per cent under the engineer's estimate. The Bureau of Highways is unable to offer any satisfactory explanation of this and states it would be necessary to get in touch with the individual contractor to ascertain the reason. The same contractors come back year after year and submit bids on various proposals and it is seldom that a contractor fails to complete a job or is unsuccessful in business. The engineer's estimate is based on the quantity of material to be delivered on the job at standard market prices for standard grades; the job is figured on the basis of the consistent number of working days and labor is figured at the prevailing rate, so that the responsibility seems to lie with the contractor who proceeds to out-guess the engineer's estimate. Not in several years has there been a bid submitted where the engineer's estimate was exceeded. No detail of how the total in the estimate is reached is given to the contractor; he simply has available in the proposal a lump sum estimate of what the engineers of the highway department fix as their estimate."

ENGINEER'S ESTIMATE OF CONSTRUCTION COST COMPARED WITH ACTUAL BIDS ON STATE HIGHWAYS

Highway No.	Length in Miles	Engineer's Estimate	Lowest Bid	Highest Bid	Average Per Cent Below Engineer's Estimate
247, 5096	3.03	$199,221	$160,103	$186,598	12
1724, 1729	1.04	77,098	60,552	68,119	18
533, 433, 5199	5.62	241,673	197,604	234,895	14
5711	4.2	199,001	155,893	193,796	15
1726	1.91	98,018	72,674	82,235	21
5382	2.4	102,862	90,447	90,447	13
444, 5377	1.29	63,968	55,301	55,633	14
5546	4.51	332,941	264,220	296,625	16
395	5.17	283,064	207,497	271,394	19
5111	1.3	77,743	60,642	70,613	15
5305	3.85	194,604	141,061	169,777	19
8248	4.24	259,460	198,873	223,951	20
8247	5.34	290,118	230,545	263,468	16
5452	2.96	257,968	197,882	219,347	18
1731	7.52	514,815	359,997	484,785	21

Relative Values of Utility Systems

Variations in Main Items Comprising Physical Values of Five Different Groups Compared

By C. F. Lambert

Burns & McDonnell Engineering Co.,
Kansas City, Mo. Los Angeles, Cal.

CLASSIFIED valuations of various items in groups of water-works and other plants, 1913 to 1924, as shown in an article entitled "Variations in Physical Values of Public Utilities," published in *Engineering News-Record*, issue of May 7, 1925, p. 768, are here brought to date of Jan. 1, 1926.

Curve No. 1 shows the relative yearly value, separately, of the labor and material, in the proportion in which each enters a power plant or pump-station building, the complete value of the building and the Government building statistics. The comparative average values for five years and ten years preceding 1924 are also shown.

Table I shows the proportion, for each year, in which the various items enter into a water-works plant.

Curve No. 2 shows the relative yearly value of water-works systems, together with curves showing, for any year, the average value for the five years and ten years preceding. In this connection, all years preceding 1913 have been taken as 100, the same as 1913.

For electric light plants we have again taken twenty-five plants in various parts of the United States. These are divided into land, buildings, boiler room, engine room and miscellaneous equipment, power transformers, lighting equipment, poles, conductors, distribution transformers, meters, underground conduits, furniture and fixtures, tools, autos and miscellaneous items, subdivided into eighty-four separate items.

Table II shows the proportion in which the various items enter into an electric light plant. Curve No. 3 shows the yearly and average values for electric light plants.

For street railways we have taken ten different systems. The street railway values do not include any power plant buildings or equipment, as the power is so frequently purchased from the Power Department or from a separate power company. The various items are: land, buildings (car barn and shops), tangent track, special layouts, grading, paving, bridges, span construction, poles, conductors, cars and equipment, furniture and fixtures, tools, autos and miscellaneous items, subdivided into eighty-two separate items.

Table III shows the proportion in which the various items enter into a street railway system. Curve No. 4 shows the yearly and average values for street railways.

For natural gas systems we have taken eleven different systems. The various items are: land, buildings, holders, miscellaneous equipment, cast-iron pipe, wrought-steel pipe, regulators, governors and valves, meters, furniture and fixtures, tools, autos and miscellaneous items, subdivided into fifty-eight different items.

Table IV shows the proportions; curve No. 5 shows the yearly and average values for natural gas systems.

For artificial gas systems we have taken twenty different systems. The various items are: land, buildings, boilers, gas machinery, holders, miscellaneous equipment, cast-iron pipe, wrought-steel pipe, regulators, governors and valves, meters, furniture and fixtures, tools, autos and miscellaneous items, subdivided into sixty-three different items.

Table V shows the proportions; curve No. 6 shows the yearly and average values for artificial gas systems. Curve No. 7 shows on one sheet the relative values of five different utilities.

RELATIVE YEARLY VALUES OF MAIN ITEMS ENTERING INTO PHYSICAL VALUE OF FIVE UTILITIES—1913 = 100

Table I.—Waterworks Plant

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Land	2 9	2.9	2.9	2.9	2.9	2.9	2.9	2 9	2.9	2 9	2.9	2.9	2 9
Building	11 2	10.8	11.1	13.3	16.5	18.5	20.6	25.6	20.9	19 0	20.8	20.7	20 6
Equipment	12.1	12.0	14.0	17.3	22.6	23.4	24.3	26.2	23.4	21 8	22.9	23.0	23 0
Distribution	72.7	67.1	71.3	94.1	143.2	161.1	165 8	197.8	155.8	130.1	149.8	152.2	143 2
Miscellaneous	1.1	1.1	1.1	1.4	1.8	2.0	2.3	2.8	2.2	2.0	2.0	2.0	2 0
Total	100.0	93.9	100.4	129.0	187.0	207.9	215.9	255.3	205.2	175.8	198.4	200.8	191.7

Table II.—Electric Light Plant

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Land	2 8	2.8	2.8	2.8	2.8	2.8	2.8	2 8	2.8	2.8	2.8	2.8	2 8
Building	10 1	9.7	10.0	12.0	14.9	16.7	18.5	23.1	18.9	17.1	18.8	18.6	18 5
Equipment	38.9	36.7	36.7	47.9	73.5	79.5	81.0	86.7	84.6	75.1	73.4	73.5	73 6
Distribution	44.8	43.5	47.1	56.1	63.4	69.6	75.2	82.6	77.4	70.4	70.4	69.6	71 7
Miscellaneous	3.4	3.4	3.4	4.1	5.1	6.0	6.8	8.6	6.8	6.2	6.2	6.1	6 0
Total	100.0	96.1	100.0	122.9	159.7	174.6	184.3	203.8	190.5	171.6	171.6	170.6	172.6

Table III.—Street Railway System

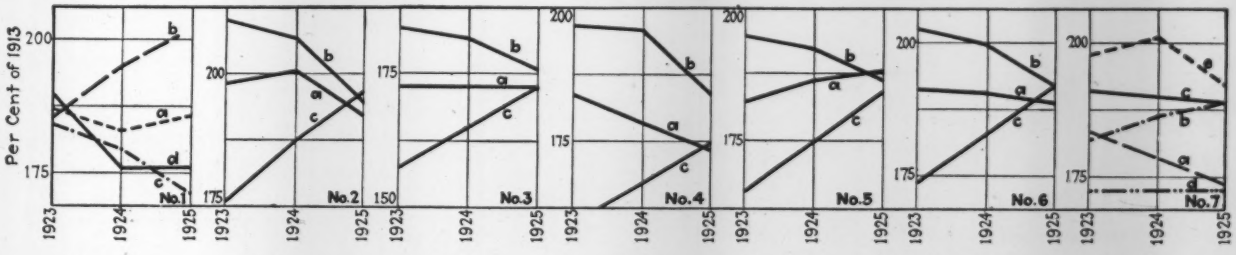
	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Land	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2 6
Buildings	4.7	4.5	4.6	5.6	6.9	7.8	8.6	10.8	8.8	8.0	8.8	8.7	8 6
Track construction	64.3	63.1	63.4	71.9	83.3	104.8	113.8	144.1	119.9	105.4	113.6	112.8	110 6
Span construction	5.8	5.4	6.3	8.7	9.9	9.7	10 0	11 1	9.0	8.5	8.7	8.8	8 1
Cars and equipment	20 9	22.4	22.8	25.1	27.2	31.1	44.4	61.1	59.1	53.0	47.0	42.9	40 9
Miscellaneous	1.7	1.6	1.6	2.2	2.9	3.2	3.5	4.3	3.6	3.2	3.3	3.2	3 0
Total	100.0	99.6	101.3	116.1	132.8	159.2	182.9	234.0	203.0	180.7	184.0	179.0	173.8

Table IV.—Natural Gas Plants

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Land	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1 6
Buildings	1.6	1.5	1.6	1.9	2.4	2.6	2.9	3.7	3.0	2.7	2.9	3.0	3 0
Equipment	1.7	1.6	1.8	2.6	4.0	3.6	3.5	4.1	3.1	3.1	3.1	3.1	3 0
Distribution	92.2	89.9	92.0	111.0	155.7	182.9	186.5	202.4	187.3	158.4	168.7	173.4	175 8
Miscellaneous	2.9	2.8	2.9	3.3	4.4	5.1	5.8	7.8	6.4	5.6	5.8	5.7	5 7
Total	100.0	97.4	99.9	120.4	168.1	195.8	200.3	219.6	201.4	171.4	182.1	186.8	189.1

Table V.—Artificial Gas Systems

	1913	1914	191	1916	1917	1918	1919	1920	1921	1922	1923	1924	1945
Land	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4 2
Buildings	6 8	6.5	6.7	8.1	10.0	11.2	12.5	15.5	12.7	11.5	12.6	12.5	12 4
Equipment	30.4	29.1	33.1	49.9	76.4	68.7	67.2	75.9	66.1	62.8	63.4	61.3	60 6
Distribution	56.5	54.4	55.6	68.1	98.3	114.8	116.5	130.4	115.6	98.2	107.5	108.6	108 6
Miscellaneous	2.1	2.1	2.1	2.5	3.1	3.6	4.1	5.5	4.6	4.1	4.1	4.0	4 0
Total	100.0	96.3	101.7	132.8	192.0	202.5	204.5	231.5	203.2	180.8	191.8	190.6	189.8



No. 1
a. Power plant building cost.
b. Building labor.
c. Building materials.
d. Government report, building materials.

No. 2
a. Waterworks, yearly value.
b. 5-yr. average.
c. 10-yr. average.

No. 3
a. Electric light plants, yearly value
b. 5-yr. average.
c. 10-yr. average.

No. 4
a. Street railway systems, yearly value.
b. 5-yr. average.
c. 10-yr. average.

No. 5
a. Natural gas systems, yearly value.
b. 5-yr. average.
c. 10-yr. average.

No. 6
a. Artifical gas systems, yearly value.
b. 5-yr. average.
c. 10-yr. average.

No. 7
Relative yearly value:
a. Street railways.
b. Natural gas.
c. Artifical gas.
d. Electric light.
e. Waterworks.

Weekly Construction Market

A DEGREE of firmness in common brick prices at New York and in steel structurals at Pittsburgh mills, as well as in most of the construction materials other than lumber, is not sufficient to turn the market from its steady downward course, evident since February of this year. The decline in materials prices has been gradual and appears less marked as the summer advances. The same condition, however, prevailed at this time last year.

Six out of seven cities show a decided depression in lumber prices, while demand, as reflected in actual physical volume of construction, is fairly well sustained. West Coast mills report the lumber movement, in that section, at the extreme low point of the season. Shipments and orders in Southern Pine mills represent smaller percentages of actual production than is the case in the Douglas fir regions.

Linseed oil advanced sharply at New York, during the week, with a rise of 5½c. per 7½-lb. gal.; Chicago market rose 8c., Minneapolis, 6c. and Denver 1c., respectively.

Steel prices show marked upward tendencies; bars particularly. Inquiries appear more active in plates; steel pipe continues in fair volume. The average price of pig-iron, however, is down about 25c. per ton from the July 15 level; scrap and coke gain in firmness. Reinforcing bars and shapes hold at last week's quotations of $2 per 100 lb., carload lots, at Pittsburgh mills, $1.90 is still mentioned on these and plates.

The most important labor development during the last week, in the construction industry, was the refusal on the part of Cleveland painters to accept a proffered wage advance of 5c. per hr. as against the 12½c. at first demanded. The strike began in March.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	+$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$4.00
Structural rivets, 100 lb.	4.50	+3.80@5.00	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	3.38	2.60	2.87½	3.77½	2.95	3.25	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	53.6%	55%	54.25%	36%	35.6@49.2%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	51.60@53.60	47.50	54.00	49.20@50.20	53.00	64.00	50.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd.	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	1.70
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	62.00	34.00	56.00	40.50	38.25@38.75	34.75	27.00	23.00	55.00
Lime, finishing, hydrated, ton	18.20	23.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00	1.50	1.85	2.25	1.60@1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	+20.40@22.40	10.50	14.10	12.00	13.75	—9@10	15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.075	.076	.075	....	.09	.12
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	075	.076	.075	.108	.09	10
Linseed oil, raw, 5 bbl. lots, gal.	+.94½	.96	1.13	+.99	1.03½	+1.14	.97	1.12	1.03
Common Labor									
Common labor, union, hour	.90⅝	.30	.....	.87½	.....	.50@.55	.55	.62½	....
Common labor, non-union, hour	.....	.25	.30@.50	82½	.45@.60	40@.45	.50	.50	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots. Labor—Concrete laborers' rate, 93⅜c.; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of July 1 the next on Aug. 5.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, f.o.b. in carload lots.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) and shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.12). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, less-than-carload lots.

Business Briefs

Call money quoted at 4 per cent, July 20; year ago 4½ per cent.

Time loans: Sixty-ninety days, 4⅜@4½; four-six-months, 4½ per cent.

Commercial paper: Best names 4 per cent; other names, 4¼@4½ per cent.

On July 1, 1926

E. N.-R. Construction Cost Index Number 207.80

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